March 1, 1944

NATIONAL PETROLEUM NEWS

TECHNOLOGY DEPT.
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DETROIT

World Oil:

Disclosure that investments by American companies linked with PRC in the proposed Arabian pipeline project would boost the total American stake in Middle East oil to a third of a billion dollars highlighted developments this week in the explosive subject of foreign oil. Other developments:

1. Industry leaders produced figures casting doubt on the value of the Arabian project from a purely economic viewpoint.

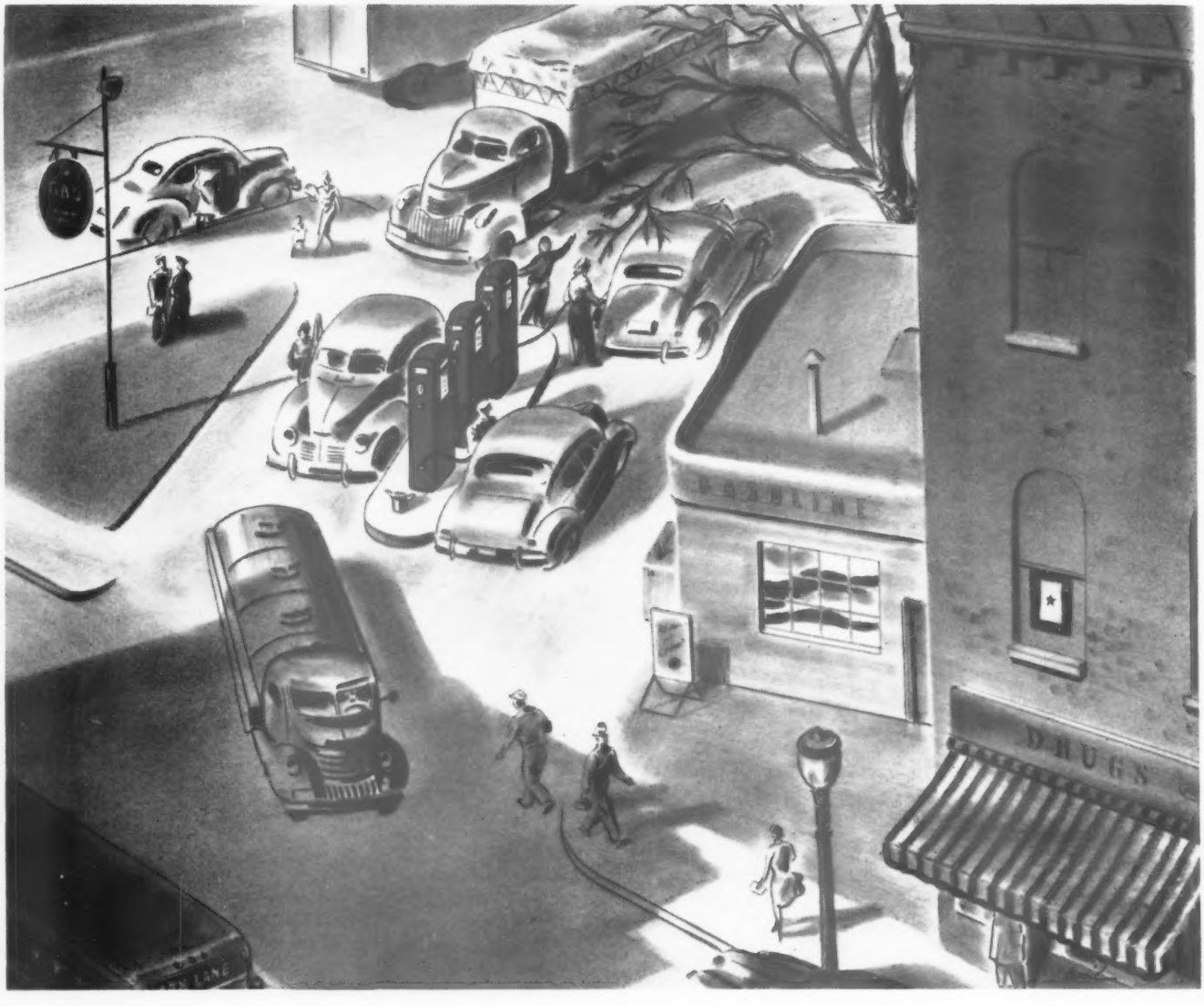
2. Prominent industry spokesmen expressed the fear that the oil policy of the Administration was dragging the country toward a policy of imperialism.

3. Herbert Yocom, in his column (p. 12) sees the U. S. heading for a serious controversy with the British over oil rights in the Middle East; Henry Ozanne, in his column on the same page, reports on the imperialistic aspects.

4. Editor Platt, p. 15, expresses the opinion that recent congressional rebellion against the president may spell finish for all phases of the Administration's foreign oil ventures.

Foreign oil stories in this issue are on pp. 3, 10 and 11.

Here are some scenes from the lush oil lands of Arabia recently projected into the public spotlight through announcement of agreement by PRC to construct a pipeline across that country from the Persian Gulf to the Mediterranean. Upper left, Arab laborers assist an American welder in a pipe laying project at Ras Tanura where it is planned to build a new refinery. Upper right, King Ibn Saud visits the discovery well in the Abu Hadriya field, north of Damman Dome where oil first was discovered in Arabia. The well visited by the king was the only one drilled in Abu Hadriya and is now shut in. Lower left, the discovery well in Damman Dome field. Lower right, a street scene in Jeddah, where headquarters of the Arabian American Petroleum Co. are located



FIGHTING THE BATTLE OF FUEL – AT HOME!

In thousands of towns and cities across America, the battle of fuel is raging. Civilian patriots, both men and women, are taking up positions at the corner service station to fight for freedom at home with fuel. For fuel fights at home as well as at the front. The cars and trucks and buses that ply our streets and highways need fuel to move, and move they must. For a let-down in transportation means a let-down in war production. And this we cannot afford. Tokheim is proud of its part in the battle of fuel, proud that the skill and talents of its workers are being applied to victory at home as well as on the fighting fronts.

TOKHEIM OIL TANK AND PUMP CO.
Designers and Builders of Superior Equipment
FORT WAYNE For 43 Years INDIANA

ARMY NAVY

MONEY FIGHTS, TOO — BUY WAR BONDS

QUALITY TOKHEIM GASOLINE PUMPS

Keep Your Pumps Pumping; *write for copy of valuable booklet describing and illustrating care of gasoline pumps. It's free!*

Facts and Flashes

From the
ETHYL CORPORATION
Chrysler Building, N. Y. C.

The guy who first said, "Every knock is a boost" certainly wasn't in the gasoline business. Even in wartime the average car owner doesn't cheer when he hears his engine go "ping ping ping" every time he tramps on the accelerator. Gasoline dealers are hearing more and more complaints about knocking.

There's little prospect for any increase in octane numbers of civilian gasoline. But even if a customer comes in with a "knock" in his engine and a chip on his shoulder, there's no reason why he shouldn't go out smiling. It's just a matter of knowing the answers.

The line one informed operator takes—and it's sound from an engineering standpoint, too—is both truthful and helpful. He says something like this:

"Yes, Mr. Smith, gasoline these days isn't what it was. That's because the cream of our gasoline goes to the Army and Navy. Don't push wartime gasoline too hard. You can't expect the same performance you got from prewar gasoline. Cut out the fast starts, shift gears on hills, generally take it easy and you'll avoid most of the knock."

In cases of severe knock, mechanical work may be necessary. The octane requirements of many cars on the road have increased due to carbon deposits, parts working out of adjustment, etc. Points which should be checked to avoid knock are the following: 1. Excessive carbon deposits. 2. Faulty distributor mechanism. 3. Incorrect spark timing. 4. Improper cooling—slipping fan belt, clogged radiator, etc.

* * * *

Recent report of the Automotive Safety Foundation shows how wrong the expression "pleasure car" really is. A survey indicates the passenger car is essentially a utility vehicle—77% of all trips are for business purposes and 90% of all trips are for less than 30 miles.

* * * *

To train a pilot for the American air forces takes an average of 12,500 gallons of high-octane gasoline.

Late Flash

Watch Congress for action on post-war road construction. H.R. 2426, now before House Roads Committee, calls for authorization to construct roads and highways at the rate of $1,000,000,000 a year for three years beginning with the close of the war. Definite action is expected soon, as objective is to clear up necessary preliminary legislation to avoid post-war delays.

Robert G. Dunlop . . .

Named Sun Comptroller at 34

ROBERT G. DUNLOP, new Sun Oil Co. comptroller and board member who succeeds to the post left vacant by the death of Frank S. Reitzel, is one of the youngest top executives in the industry. He is only 34. "And," says another Sun official, "the day the news was released was probably the first time anyone around the Sun company had ever heard Mr. Dunlop referred to except as 'Bob'."

Bob Dunlop was born in Boston, July 2, 1909, and when quite young his family moved to Collingswood, N. J., where he attended school and was graduated from the Collingswood High School in 1927. His father then told him he would pay his tuition at college but otherwise he would have to support himself. And this Bob did at the University of Pennsylvania, working after school hours, and winning the Charles Lennig Scholarship awarded by the Wharton School of Finance and Commerce of the University. While there he became editor-in-chief of the Record in 1931 and was inducted into Beta Gamma Sigma, national honorary scholastic fraternity of finance and commerce.

He was graduated from Penn in 1931, valedictorian of his class. After two years with a firm of accountants, he came to Sun where his initial activities included a survey of all producing, refining and marketing plants in respect of their operations under NRA. In 1939 he helped in the preparation of the testimony presented by the petroleum industry to the Temporary National Economic Committee.

In 1941 he was made assistant comptroller of Sun. When Mr. Reitzel was chairman of the A.P.I. committee to study uniform methods of oil accounting, Bob Dunlop was associated with him in that work and helped in the revision of the Uniform System of Accounts for the Oil Industry, later adopted by the A.P.I.

Mr. Dunlop's hobby is his work with boys' organizations and he is an elder in the United Presbyterian Church of Drexel Hill. He married Miss Emma Brownback of Parkerford, Pa., and they have two children, Barbara, 5, and Richard, 1. They reside at Drexel Hill, Pa.

NEW WARTIME EDITION
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BULLETINS

WITHHOLD PLEA ON WELL SPACING

WASHINGTON—The national Conference of Oil State Regulatory Authorities failed this week to go through with their scheduled demand for return of control over well-spacing and production operations to the states. Members of the conference came here prepared to seek revocation of PAO-11, only to hold up action after hearing PAW Production Director Knowlton outline PAW's case on behalf of continuing that regulation.

* * *

HINT SECOND CANOL PIPELINE

WASHINGTON — Army is already considering construction of a second pipeline outlet for crude from Norman Wells field in Canada, following completion of pipeline to White Horse, according to Senate Truman Committee members. Committee members expect Gen. Somervell, of Army Service Forces, to come to Congress soon with request for funds. When and if additional funds are sought, Gen. Somervell will be asked to report on status of renegotiation of agreement with Canada and Imperial Oil, Truman group indicated.

* * *

WIRT FRANKLIN RESIGNS

WASHINGTON — PAW Feb. 29 announced resignation of Wirt Franklin, special field assistant to Deputy PAW Davies. Mr. Franklin is expected to run this fall for election to the U. S. Senate. He has been with PAW since August, 1941, when he became Dist. 2 director of production.

* * *

WHITMAN TO SUCCEED DEAN

WASHINGTON—A. R. Whitman, connected with Benton & Bowles advertising agency in New York City before coming to Office of War Information in Washington in February 1943, is slated to take over Joel Dean's job as OPA fuel division director on March 6. OPA Chief Bowles is partner in concern.

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NATIONAL PETROLEUM NEWS

March 1, 1944
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Reveal Vast U. S. Stake in Arabian Oil

Companies May Invest Up to $150,000,000 in Addition to PRC Outlay; Project Bitterly Assailed at P.I.W.C. Meeting

By Herbert Yocom, Chief, NPN Washington Bureau

WASHINGTON—The truly vast scale of plans for the development of America's oil interest in the Persian Gulf area became apparent at last this week with disclosure that they presently contemplate the expenditure of more than one-third of a billion American dollars.

The three American company participants in the unprecedented program alone are planning on investing at least $150,000,000 in carrying out their end of the deal with PRC whereby the federal government will finance, build, own, operate and maintain a "big inch" trans-Arabian pipeline that may cost as much as $165,000,000.

Add to these amounts the $52,000,000 cost of Arabian-American Oil Co.'s new refinery at Ras Tanura, on the Persian Gulf—a project that presumably will feed products eastward—and the total sum to be expended reaches the astronomical figure of $367,000,000.

Hill Brief Attacks PRC

Disclosure of the vast size of the projected development program highlighted a week which saw P. I. W. C. preparing to renew its demand for the liquidation of PRC. There had been no action by P.I.W.C. up to the time NPN went to press, but members of the council's oil policy committee, headed by John A. Brown, after an all-day session, said they would press for adoption of a resolution which would again express the opposition of the industry to direct or indirect government participation in foreign oil operations.

Before the council, as it met Wednesday, was a lengthy brief prepared by George A. Hill, of Houston Oil Co. of Texas, attacking the very idea of PRC from beginning to end.

Gotten out in printed form by I. P. A. A., Mr. Hill's brief assailed the "planned action" of PRC as "the beginning of a fatal and mistaken policy, as grave as the fatally mistaken policy of scrapping much of our fleet voluntarily at the end of the last war."

Termed "Fascist Approach"

"It is the fascist approach, (the corporative state, with its lust for imperialism),—the shackling of free American enterprise, not to better serve, but to displace private enterprise, at not only the risk, but with the certainty, of international political involvement," Mr. Hill declared.

John A. Brown . . . Heads P.I.W.C. Oil Policy Makers

Meantime, the senate again delayed action on the Moore-Brewster resolution (S. Res. 253) proposing the creation of a special investigating committee charged

(*Continued on p. 10*)

Oilmen Hit Pipeline as Imperialistic; Doubt Gain

NPN News Bureau

NEW YORK—Industry protest against PRC's trans-Arabian pipeline scheme was crystallizing rapidly over the week-end. Executives of half a dozen major oil companies were informally but openly voicing criticism of the deal, with complaints focused around two issues:

1. **The value of the project is doubtful from purely economic considerations,**
2. **It is a hazardous imperialistic venture for the U. S. as a nation.**

Simply from the engineering point of view, oil executives pointed out, the Arabian project does not acquire any new oil rights for Americans, nor does it make accessible any oil not already accessible. All that it does, they affirm, is to reduce the transportation cost of the oil to the European markets by an amount estimated at 15c, or perhaps 20c a barrel, equal to less than half a cent a gallon.

Another surprise was sprung when industry experts computed that even the transportation economy was largely mythical because the total savings of the line would work out to just about the Suez Canal toll. As one industry official said: "To the extent that this is a war measure—as it is claimed—the whole thing is unnecessary and the same result can be achieved by Britain waiving the canal toll on war shipments, a rather slight

(*Continued on p. 10*)

Stranded Tourists Wail As Florida OPA Roars

Special to NPN

ST. PETERSBURG, Fla. — Hundreds of northern visitors who drove their automobiles to Florida resorts this winter have found themselves stranded because local rationing boards, complying with national OPA regulations, have refused to grant supplemental rations to return to their homes.

A committee representing the President's Union, St. Petersburg tourist group, met with the city's rationers Feb. 23 in an effort to determine whether or not extra gasoline rations would be issued in special and deserving cases. They were told the board had no discretionary powers.

The President's Union group, at first reported to have asked a blanket allowance for tourists to return North, brought down the wrath of State OPA Director Chauncey Butler, Jacksonville, who said: "It is about time we checked on how the tourists drove their cars to Florida in the first place."

Chairman Milton I. Stewart of the Daytona Beach board said: "Visitors have no reason to hold the local board responsible for an error made by a northern rationing authority."

Mr. Butler directed local boards throughout the state to check licenses of visitors applying for extra gasoline to return North. He said that in most cases the tourists had obtained gasoline to come to Florida by misrepresentation.

License numbers of 18 cars from the Buffalo-Rochester area, obtained by OPA investigators in Florida, have already been reported and an investigation is reported under way to ascertain how they got to the state.

Army to Ask Bids Next Week On 11,000 Used Trucks

NPN News Bureau

CHICAGO — Invitations to bid on some of the 11,000 used trucks which the Army recently announced it would release for civilian use will go out around March 6, the Treasury Department here announced Feb. 25. Bidding, however, will be limited to dealers only, in line with new stipulation added to release of the trucks.

Between 300 and 400 trucks, truck chassis, and other types of equipment are being offered for first bidding.

Postwar Era of Greater Oil Use Is Forecast Before Mine and Metallurgic Engineers

By Henry Ozanne, NPN Staff Writer

NEW YORK—Problems of petroleum production, refining and marketing, as well as the broad question of a U. S. domestic and foreign oil policy occupied several sessions of the annual meeting of the American Institute of Mining and Metallurgical Engineers here Feb. 20-24.

C. L. Burrill, petroleum economist of the Standard Oil Co. (N. J.), spoke on "Estimated Consumption of Petroleum Products in the United States After the War." He predicted that the nation's business activity (as measured by industrial production) would be higher in the next six years than it had ever been during a peacetime period of the same duration.

As a result, he estimated, the total demand for all crude and product would reach 1,872,800,000 bbls. in 1950, or 5,000,000 b/d, accompanied by a decline in exports. All his estimates were predicated on the end of the war in Europe this year and in the Orient by the end of 1945.

Total demand for all gasolines was estimated at 649,000,000 bbls. in 1946, only 6.5% less than the pre-war peak demand of 1941. Mr. Burrill said: "A sharp increase, almost entirely attributable to passenger car consumption, is indicated for 1947, and by 1950 total demand is estimated at 862.500,000 bbls., 24% greater than in 1941."

Large Increase by 1947

Consumption per car per year was put at 10.5 bbls. in 1944 and 18.5 bbls. in 1947 and 1948, declining to 18 bbls. in 1950. The 1941 average was 16.6 bbls. Truck and bus demand, he said, would go from 140,000,000 bbls. in 1946 to 180,000,000 bbls. in 1950. Agricultural demand for gasoline will maintain a level of 30,000,000 bbls. a year until 1950, Mr. Burrill predicted.

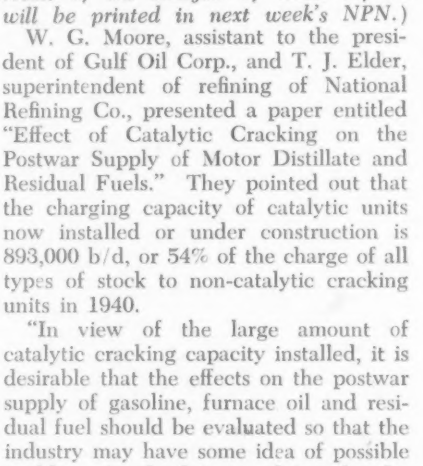
Demand for aviation gasoline, he estimated, would nearly double between 1946 and 1950, the figure of 17,000,000 bbls. a year being the estimate for 1946 against 30,000,000 bbls. a year for 1950.

Dr. Burrill said residual fuel oil demand would rise from 353,000,000 bbls. in 1946 to 413,000,000 bbls. in 1950, against 383,339,000 bbls. in 1941. Kerosine demand would rise, he forecast, from 72,000,000 bbls. in 1946 to 80,000,000 bbls. in 1950, compared with 70,023,000 bbls. in 1941. Distillate fuel oil demand he placed at 190,000,000 bbls. in 1946 and 252,000,000 bbls. in 1950, compared with 174,034,000 bbls. in 1941. Lubricating oil demand increase he set at 27,800,000 bbls. in 1946 to 35,900,000 bbls. in 1950 against 31,400,000 bbls. for 1941.

(*Result of several industry surveys forecasting new peacetime highs in automobile output and fuel consumption in the postwar period and a further elaboration of Dr. Burrill's findings as the result of his analysis of these reports will be printed in next week's NPN.*)

W. G. Moore, assistant to the president of Gulf Oil Corp., and T. J. Elder, superintendent of refining of National Refining Co., presented a paper entitled "Effect of Catalytic Cracking on the Postwar Supply of Motor Distillate and Residual Fuels." They pointed out that the charging capacity of catalytic units now installed or under construction is 893,000 b/d, or 54% of the charge of all types of stock to non-catalytic cracking units in 1940.

"In view of the large amount of catalytic cracking capacity installed, it is desirable that the effects on the postwar supply of gasoline, furnace oil and residual fuel should be evaluated so that the industry may have some idea of possible problems involved in supplying the demand for these products", the authors stated. In comment on this question the authors said there would be a substantial increase in the amount of light products obtained from a barrel of crude, which may be taken either as gasoline or distillate fuel, and a substantial reduction in the amount of residual fuel oil.



C. L. Burrill . . . . Foresees record prosperity for the industry

Two Factors to Reduce Fuel

While the amount of residual fuel oil per barrel will be less, the quantity of crude run will also determine the total supply, they said. Two other factors that would tend to reduce the fuel supply are (a) utilizing the heavier portions of the crude for charging to catalytic units and (b) further installations of catalytic units."

Gasolines of higher octane number will be made, they said, and the proportion of cracked to straight run will increase.

The quantity of distillate fuel that can be made will be substantially greater and there will be a material increase in the percentage of cracked furnace oil in fuels for household heating.

There will be an increase in the production of gas but the butenes above vapor pressure requirements, and possibly the propenes, will be utilized for the production of high-octane blending components for aviation and motor gasolines.

With increased cracking capacity, the tendency probably will be to use otherwise idle capacity for cracking stocks now in the reduced crude sold as fuel or vis-broken. This will reduce the volume of residual fuel.

John D. Gill, and B. A. Stainton of the Atlantic Refining Co., offered a paper on "Prudent Investment in the Petroleum Industry". The authors said that an examination of the history of capital investment in industry in general from 1929 to 1939 indicates clearly "that the petroleum industry's investment was as sound as that of any major industry, and in fact sounder than most." The net assets of all manufacturing companies declined 30% in the period from their peak in 1930, whereas 24 oil companies —about a 70% sample of the industry— found it necessary or advisable to eliminate only 18% of their net capital assets.

Cite 1929 Comparison

"In 1937 manufacturing industry as a whole was able to produce 3% more goods than in 1929 with 24% less plant and equipment; the oil companies, on the other hand, had 23% more production in 1937 than in 1929, but required 14% more plant and equipment to do it. The figures indicate very strongly that the oil industry had less excessive or useless capacity, which presumably would indicate imprudent investment, than any other large industry."

The industry, the authors showed, employs vast amounts of capital at the saving of large amounts of labor. This is demonstrated by the fact that in 1940 capital invested per worker in petroleum refining was $16,200, which was far greater than in the case of almost any other industry.

"Superficial critics have harshly criticized the apparent surplus capacity which has sometimes resulted," they said, "but the cost to the public has actually been but a small fraction of the values of the products which the developing technology provided." (*Story on financial study of 30 representative oil companies made by Dr. Joseph E. Pogue and Frederick C. Coqueron starts on p. 19*).

Sidney A. Swensrud, vice president of Standard Oil Co. (Ohio) read a paper on "The Possibility of Converting the Large Diameter War Emergency Pipe Lines to Natural Gas Service After the War." He

(*Continued on p. 41*)

Dist. 2 Allocation Argued Hotly in Preliminary Draft

NPN News Bureau

CHICAGO—The original draft of the gasoline allocations order proposed for Dist. 2 when and if the shortage of supplies in the Midwest makes it necessary contains several points objectionable to independent operators. The first draft was not a great deal different from PAW Directive 59, which has been effective in Dist. 1, and the proposed order here, understood to have been drawn up by PAW in Washington, has been passed around among various industry committees for study and revision to eliminate the "bugs" and fit it to supply and distribution conditions peculiar to this area.

Last week the special allocations subcommittee headed by C. B. Watson of the Pure Oil Co. held what was supposed to be a final meeting to give the preliminary order a brushing up to put it in form for passing on to the Dist. 2 general committee for approval before it goes to PAW for handling. Whether the order form presented by the industry will be acceptable to PAW remains to be seen, but Dist. 2 Director Vandeveer is expected to give it a thorough airing on the public clothesline before it is put into effect.

Conversation in the industry generally indicates considerable faith has been placed in his fair judgment, but whether or not independent jobbers get everything they want can not be determined until the actual order comes out.

However, B. L. Majewski, chairman of the Dist. 2 marketing committee, who appointed the allocations subcommittee and said he was a visitor at the subcommittee meeting last week, told the Iowa Independent Oil Jobbers' Assn. in convention at Des Moines on Thursday that independents got everything and major companies nothing in the proposed order form being drawn by the subcommittee. Since he did not elaborate, the exact meaning of his statement is not clear.

Object, but Admit Need

Principal objections to the order expressed by the several oil men with whom NPN discussed it is that it would be another restrictive government regulation issued at a time when government control of the industry should be easing off, although they admit that in a desperate supply circumstance something must be done to compel a fair distribution of available products.

The order, in whatever form issued, they say, would be double rationing—more red tape to claw through—and OPA has allowed no increased margins to offset the increase in expense for handling coupons and the things that go with them, although the appeal for relief has been almost continuous.

According to word on the outside of press-barred committee doors, the committee battles inside have centered around demands of independents that allocation be extended on down from primary supplier to jobber level so that major companies cannot grab everything for their own outlets. Certainly, independent jobbers not on any of the committees, and who have not yet had a look-in, stress this point in resolutions passed at their annual meetings.

Other points on which the independents wax ardent are the subtraction of "war needs", what it should include and what balance will be left for allocation for civilian use. Aviation gasoline should obviously be included, but how about farm supplies? Farmers sometime ago were classed with military essentials, but if farm supplies are deducted before allocations start, not much will be left to allocate.

Allocation on Jobber Level

At the subcommittee meeting last week, NPN learns, farm supplies were lifted from war needs and thrown in with supplies to be allocated. If that condition sticks in PAW's final order, independent jobbers who handle no war supplies will be satisfied on the point.

Primary suppliers, the subcommittee also decided, are to give jobbers the same proportion or percentage of their allocation of supplies as the percentage of volume they receive in their allocation by PAW. This in effect, brings the allocation to the jobber level. Basis of allocation is said to have been placed by the subcommittee on the average of 1941-42-43 sales on a quarterly basis, although there is still some argument that it should be on a 1943 quarterly sales basis to adjust it to wartime requirements and the migration of customers to war plants areas.

Facing Premium Loss, Jobbers Ask Data To Back Price Rise

NPN News Bureau

CLEVELAND—While oil men generally are sympathetic to the military need for possible curtailment or elimination of premium grade gasoline for civilian use, the feeling exists that, if such a step proves necessary, an additional margin should be allowed for regular grade gasoline if jobbers aren't to suffer.

In order to be prepared for such a situation and to offer OPA actual facts and figures without delay, the National Council of Independent Petroleum Assns. has prepared a form which it is having independent associations send to jobbers in every state. Information sought will show the total loss of revenue that would result to the jobbers of each state if premium grade is eliminated and will also show the exact amount per gal. increase in the price of regular that would be necessary if jobbers are to enjoy the same revenue as in 1943.

According to Phil T. Williams, N.C.I.P.A. chairman, with the information from jobbers and major oil companies, it will be possible to show the total loss of revenue to the industry in each state and also the total loss of revenue to jobbers in each state.

The South Dakota Independent Oil Men's Assn. has already asked its members for the necessary information to present to OPA.

C. E. Holmes, secretary of the Kansas Oil Men's Assn., has reported to N.C.I.P.A. the results of a survey of various jobbers and companies showing

(*Continued on p.* 40)

WHO SAID 'GAS' SHORTAGE? These farmers are dipping into a creek near Batesville, Ind., to retrieve gasoline which spilled from a leak in the Little Inch line. Although the fuel was low-test and unfit for use in motor vehicles, the farmers used every available means to help themselves to the ration-free fuel

Governor B. B. Hickenlooper, Iowa, addressing the Iowa Independent Oil Jobbers' Assn. at the banquet Feb. 24 attended by more than 500. Seated left to right: H. H. Hahn, executive secretary and L. S. Snyder, president, Nebraska Petroleum Marketers, Inc.; John W. Schultz, president and Mrs. A. C. Gienapp, wife of Executive Secretary Gienapp of the Iowa association and Brig. Gen. C. H. Grahl, Selective Service

Iowa Jobbers Give OPA Gentle Jab in Oil-for-Victory Rally

Inquire Why They're Handed Compliance Job Agency Can't Do; Urge Price Compensation if Ethyl Vanishes, Simpler Rules

Earl Lamm
NPN Staff Writer

DES MOINES, IA.—After meditating upon oil marketing problems of independent operators, Iowa Independent Oil Jobbers' Assn. at its "Victory Oil Conference" at Hotel Fort Des Moines here Feb. 23-24, passed a resolution urging OPA to continue simplifying rationing regulations and not place responsibility for enforcement of gasoline rationing on the industry after having itself failed to secure compliance.

The Dist. 2 marketing committee, PAW, OPA and Economic Stabilizer Vinson were petitioned for a half cent increase in ceiling prices of gasoline and fuel oil to cover added rationing costs to the operators and to secure better cooperation from the smaller units in eliminating "black market" sales.

A crude oil price increase, to be reflected in product prices, would help producers obtain more crude to put the 200,000 b/d of idle refining capacity in Dist. 2 to work, resulting in more products which would lessen the rationing impact, the jobbers said in another resolution.

A recommendation was made to OPA, PAW and the Dist. 2 marketing committee that if premium grade gasoline is withdrawn from civilian use, as has been indicated, that the difference in revenue between premium and house-brand gasolines be added to the existing revenue from house brand to avoid forcing hardship on distributors.

Opposition was registered to a proposed change in PAO 12 to permit lending of equipment to farmers and other customers, which was considered a poor business practice and a hazardous one, since distributors may be held liable for seepage, explosion and fire damage to farm property. Most such equipment is now old and subject to leakage. Several water wells were reported ruined by leaky underground gasoline storage tanks in rural areas. Also, major companies were said to have a lot of used equipment in warehouses, which give them an unfair advantage. Farmers now have money and are able to pay for equipment, the jobbers said.

The convention was well attended, with more than 500 at the banquet Thursday night at which time Gov. B. B. Hickenlooper spoke. He gave assurance that the oil industry's problems, whatever they were, would be solved.

"I think the solution will come from you," he said, "as operators, as individuals in free enterprise, although we are going far down the road today in destroying the free enterprise system."

Other speakers were Dist. 2 PAW Director Vandeveer; Brig. Gen. Charles H. Grahl, Selective Service; D. Oty Groce, chairman, Dist. 2 jobbers' subcommittee; Leland L. Harms, member Dist. 2 marketing committee; George C. Lloyd, secretary, Iowa Petroleum Industries Committee; Edward F. Stegan, OPA Chicago; B. L. Majewski, chairman, Dist. 2 marketing committee and Warren C. Platt, editor and publisher of NATIONAL PETROLEUM NEWS.

The convention slogan was "Do More in '44!" Mr. Vandeveer in his 18th "grass roots" address declared it was not easy to forecast the problems which will face the industry this year, but suggested a few:

1. A definite shortage of crude in this country, unless new discoveries exceed expectations or military requirements fall considerably below present estimates.
2. Manpower situation, already critical, will probably become worse.
3. Steel and other materials for oil industry operations will continue scarce, and must be distributed for maximum use.
4. Transportation problems will continue to cause minor dislocations.
5. Refining capacities will be taxed to efficiency limits, especially 100-octane plants. Refiners will be handicapped by necessity of processing some inferior grades of crude and there is a possibility that products for civilian consumption may have to be further lowered in quality in the future. Civilians will not get more, and may get less petroleum products.
6. Continuing efforts will be made to divert more of the petroleum burden to foreign oil sources.
7. Equitable distribution of crude to refineries and of finished products to the ultimate consumer will continue to be a basic consideration.

"Within a few days," Mr. Vandeveer continued, "the farmers in Iowa will begin spring plowing. This farm activity will play a definite part in the war pro-

Doubts Coupon Cut

DES MOINES—Dist. 2 PAW Director Vandeveer, officially answering a direct question from the convention floor at the Iowa jobbers convention here declared that until PAW's certification of supplies to OPA is changed (now 433,000 b/d of gasoline for Dist. 2 during first quarter), OPA has no basis for reducing "A" cards from three to two gallons in the Midwest and refusing to issue supplemental "B" and "C" cards partly to offset the difference, which published Chicago reports said OPA was going to do between March 1 and 15. The story caused a flurry of excitement among oil jobbers meeting here.

gram, since the farmers of the Middle West produce the food that fights for freedom . . . The people in your town will expect you to keep them informed on the problems of the oil industry. Therefore, I want to caution you against making statements which might be misinterpreted."

He urged the jobbers to let their friends and neighbors know the important job petroleum is doing and the tremendous task the industry has to perform. "We should remember," he concluded, "that the western European invasion has not yet even started and our toughest months are ahead."

Prefacing his talk on the marketing outlook, Mr. Majewski said: "The proposed products allocation plan on which we have been working is illegal in my opinion, and we don't want it if we can help it."

Preliminary draft of the allocation plan has been under study by PAW and various functional industry committees for some time, and last week a Dist. 2 subcommittee discussed it for a full day, "and every jobber who asked for anything is going to get what he wants when the subcommittee and the marketing committee make up their revised draft of the plan," Mr. Majewski said.

"If the new plan puts anybody out of business or hurts anybody," he continued, "we are going to throw it out the window and get Mr. Vandeveer to help us. He has helped us in the past."

In the subcommittee hearing last week, he said, the major companies got nothing and the independents got everything.

Referring to the possible elimination of Ethyl gasoline for civilian use, he said the industry marketing committee was committed to there being no change without at least 30 days' notice.

The new marketing and distribution committee—a part revision of the old S. & D. committee now pending,—is expected to include four new jobbers, one independent refiner and "one other who will vote for us," Mr. Majewski said. He also added that the industry was going to get more military information than heretofore, as a chart showing the division of supplies between military and civilian uses was going to be released for publications by April. The chart in question, he said, was shown to PIWC in secret recently.

Iowa farm business was an important topic for discussion by all oil men at the Iowa Independent Oil Jobbers' Assn. convention. D. F. Atkinson, manager, Skelly Oil Co., Cedar Rapids, left, and Floyd Perkins, Perkins Oil Co., De Witt, talk over industry problems

Jobbers have received many direct benefits from industry committee activities, Mr. Harms said in his talk. He called the jobbers to account for lack of support and urged them to get behind the committees by making known their wants, then pushing for results.

Many jobbers probably do not approve of some committee actions, he continued, referring to the station hours directive which was later killed. He said that the directive was a recommendation of the Iowa association's board of directors and that he helped push it through committee approval.

Members of the committees have a look at most orders before they are issued, he said, and are allowed to make suggestions to improve them for the benefit of jobbers. As examples of committee activities which have brought direct benefits to jobbers, he put his finger on a couple.

"You all remember when the joint use of marketing facilities and suggested

(*Continued on p.* 36)

Seventy-two ladies attending the Iowa Independent Oil Jobbers' Assn. "Victory Oil" conference in Des Moines, Feb. 23-24 were entertained at a luncheon by the ladies reception committee. Mrs. A. C. Gienapp, right, was chairman of the committee, assisted by Miss Katherine Moody, center, and Mrs. Earnest Peters.

WAR OIL NEWS from WASHINGTON

HERBERT YOCOM *Bureau Chief*
NATIONAL PRESS BLDG.
NATIONAL 3477

Briefs from Week's News

Barely Making Both Ends Meet In East, Davies Reports

NPN News Bureau

WASHINGTON — Reporting on the still precarious situation as regards East Coast supplies, Deputy PAW Davies Feb. 24 said "We are barely with difficulty making both ends meet. We are at a point in the mid-winter peak demand where every gallon counts."

Heating oil supplies showed a sharp drop during the week ended Feb. 19, he said, but kerosine stocks "were fairly well maintained". Residual fuels improved while gasoline supplies were kept high enough "to meet present rationed demand".

"The principal domestic problem at this time," Mr. Davies added, "consists in providing the enormous quantities of heating oil which are consumed on the Atlantic Coast in winter. The disappointing delay in completion of the 20-in. pipeline from Texas, due to defective materials, has placed a special strain upon our other transportation facilities and reduced our operating margins to uncomfortable levels."

"Satisfaction can be felt in the fact that the military demand—colossal in size—continues to be met in full," he added.

OPA Earmarks 10,000 New Cars As March Civilian Quota

NPN News Bureau

WASHINGTON — Ten thousand new passenger automobiles will be available to civilians under rationing in March, OPA announced Feb. 28. The quota is the same as for February and applies only to new 1942 cars. While used 1942 cars will still be subject to rationing, issue of certificates will not be restricted by quotas.

Distribution will be as follows:

	Quota	Reserve
Boston	584	36
New York	1,730	110
Cleveland	1,503	107
Atlanta	1,479	109
Dallas	1,613	117
Chicago	1,330	100
Denver	300	26
San Francisco	1,461	95

OPA's Mind Nearly Made Up on Stripper Subsidy; 5, 6 and 7-Bbl. Well Fields Slated for Bonuses

NPN News Bureau

WASHINGTON—OPA's stripper well subsidy plan (*see NPN, Feb. 9, p. 8*) is almost ready to go to Economic Stabilizer Vinson and awaits only whatever suggestions and criticisms the Independent Petroleum Assn. of America and the National Stripper Well Assn. may have to offer after meetings in St. Louis scheduled for March 8, 9 and 10.

Led by I.P.A.A. President Ralph Zook and General Counsel Russell Brown, a group of representatives from the association met a week ago with OPA Oil Price Chief Sumner Pike and other members of the price branch for a look-see at the subsidy plan.

Although the plan at that time was nearing completion and ready to go down on paper for Judge Vinson's review, the price agency agreed to hold off until the industry could thoroughly discuss the matter and present its views on the subject.

But, even though the plan as yet is not in formal shape for presentation, pressure may come either from the direction of the economic stabilizer's office or from the banking and currency committee of the Senate, which already has set up a special sub-committee to hold hearings on the Disney and Thomas crude price bills. Thus, OPA may be ordered to get its informal memos on the subject into a concrete document so that it can be studied as soon as possible by one or both of the above. However, OPA is desirous of waiting until the industry can present its suggestions before going further. Officials admit that it is a complex problem and deserves the study of any and all who can present suggestions.

What OPA Thinks

As this is written, OPA's thoughts on the subject have boiled down to about what follows:

1. Figured on a field-wide basis, all fields which showed an average daily production of 5 bbl. or less per well would receive a 30% price increase "bonus", fields with 6-bbl. wells would receive a 20% bonus, and 7-bbl. well fields would receive a 10% bonus.

OPA's earlier ideas on the definition of stripper well fields have resolved themselves as outlined above, and other considerations, such as daily gross dollar volume of production and depth of production, have been discarded.

2. The higher prices allowed stripper well fields eligible to receive the "bonus" increases would be passed on to refiners who in turn would be reimbursed by the government for bonus increases allowed producers.

As to what the refiner, working on short capital, would do when squeezed by these higher crude prices, subsidy proponents suggest that as the program gets initially under way, the refiner would pay the usual price per barrel to the producer and then, later, pass on a check to the producer for the amount resulting from the bonus increase after being reimbursed by the government. Officials who have worked on the OPA plan admit it might be "several weeks" between the time a refiner entered his "claim" and the time he received a government reimbursement, but they expect that the time lag would not be much more than a month or six weeks.

Small Wells Bulk Large

3. It is estimated that the 5-bbl. well, on a field-wide basis, constitutes approximately 60 per cent of the country's wells, while this figure might go to about 67 per cent or so if 6-bbl. and 7-bbl. fields are taken into consideration. Production by these wells, it is said, probably constitutes about 12 to 15 per cent of the nation's production.

Based on the above figures, OPA estimates that the subsidy program would probably entail government expenditure of about $65-75,000,000 annually compared, OPA says, with a cost to the country's oil consumers of about $500,000,000 if a 35-cent increase were granted.

After delving deeper into possible legal authority for payments to refiners under OPA's "bonus" plan, Economic Stabilizer Vinson's office, it is reliably understood, has finally determined that such authority already exists and that no further appropriation would have to be voted by Congress.

Funds which Judge Vinson is eyeing are probably those of Defense Supplies Corp., RFC subsidiary, whose "grab bag" is now being used to finance war-added transportation costs on crude and products moving to the East Coast and from Texas into Dist. 2. Once the plan is worked out by OPA and approved by Judge Vinson, its operation will probably center in DSC or some other RFC subsidiary.

As pointed out above, the OPA plan is still being considered on a field-wide basis, rather than well by well. This latter setup, officials say, would be impossible to administer. Thus, if a producer in a field which came under OPA's stripper well definition (average production per well either 5, 6 or 7 bbl. daily) had wells producing at a much higher rate, he would still be eligible for "bonus" payments. OPA points out that under this system, some producers will receive a windfall, but they believe that this should be ignored so that the plan can be got into operation.

Definition Arbitrary

In developing its plan, OPA has found it necessary to be arbitrary in defining which fields shall be eligible for "bonuses" but officials point out that it obviously will be necessary to examine other production operations which do not come under OPA's definition.

One outstanding example would be

a field where water production is high compared with oil produced. Another might involve a field which until recent times had been manifestly "stripper" because of low production and then had pushed into the higher production class because of one or more wells drilled beyond a possible fault in the field's structure. This case, it is admitted, would be ticklish to handle.

In fields in which they believe are eligible for "bonus" payments, but which do not come under OPA's arbitrary definition, producers will be asked to set up a "field committee" to study the situation and come to OPA for decision. In fields like those mentioned above, it might be suggested to the producers that they rearrange gathering systems, splitting the stripper-well side of the field from the flush production side.

OPA has also considered, as part of its production-stimulation bonus program, granting a straight 10c per-barrel increase to all production in the country. But this angle has been divorced completely from the present plan since it is felt that such a move would merely provoke further argument for a straight increase of 35c or 50c per bbl.

WPB Releases 1568 Vehicles

NPN News Bureau

WASHINGTON—A total of 1568 vehicles was released under truck rationing between Feb. 13 and 19 WPB announced Feb. 28. The total included 258 light, 680 medium, 267 heavy trucks, 343 trailers and 20 third-axle attachments.

OPA Ready to Crack Down on Faulty Coupons; Bowles Asks Motorists Ease Burden on Dealers

NPN News Bureau

WASHINGTON—In a further effort to wipe out the black market in gasoline, OPA Chief Bowles this week urged all motorists immediately to endorse all their gasoline coupons, if they have not already done so. At the same time he warned that a check of all gasoline ration books will begin the week of March 6.

"Gasoline dealers have been carrying too heavy a share of the work of our rationing program," Mr. Bowles said. "They are doing a swell job, but they need more help than they have been getting from us and from the public. It is our responsibility to go to the people who drive cars and explain to them the importance of doing their part. We have been lax on that job—perhaps we did not realize how much we needed to explain coupon endorsement—but we intend now to make up for lost time."

Mr. Bowles termed the gasoline black market "one of the most serious threats that there is today to our civilian life and work" and said it is placing a severe strain on the country's wartime distribution system.

"The gasoline siphoned every day out of our limited supply by organized burglars, counterfeiters and racketeers, for the benefit of the minority of people who are intent on grabbing a larger wartime share than their neighbors," he added, "is robbing all honest motorists of gasoline that belongs to them."

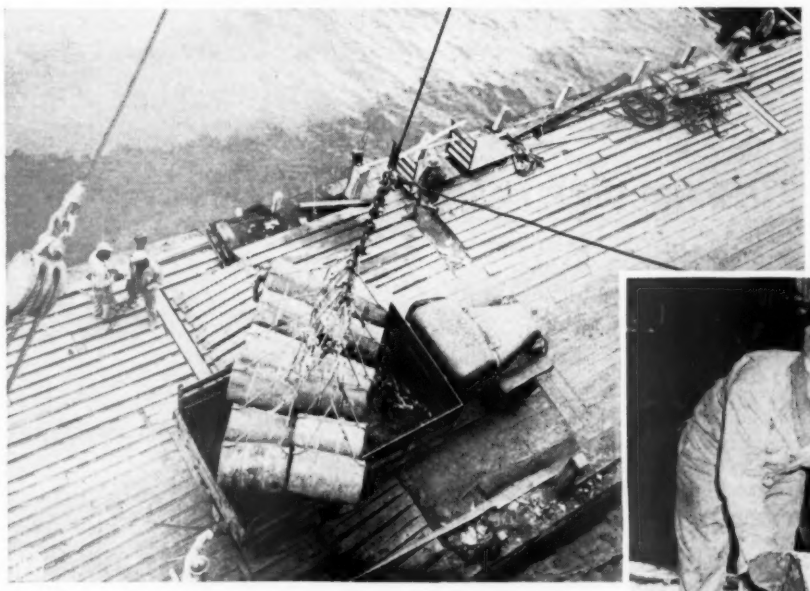
"To stop this drain on our limited gasoline stocks and to protect the full ration share of every honest motorist, OPA's small enforcement staff is working long hours, trying to be everywhere at once, tracking down and rounding up the gangsters and profiteers who are responsible for it. But the OPA with its limited resources cannot do the job alone. The simplest thing that every motorist can do to help us is to endorse every one of his or her gasoline coupons at once."

Mr. Bowles' message led off a nationwide drive to have motorists write their license number on all gasoline coupons. It will be climaxed with a check of gasoline ration books beginning the week of March 6. Any ration holder found with unendorsed coupons after that date will be given a notice explaining the endorsement requirement and directing him to show fully endorsed books to his local ration board within 10 days. If he does not do this, the notice tells him a hearing will be held on a given day to determine whether his rations should be revoked.

Gives Dealer a Break

Main reason for requiring endorsement of coupons by motorists, Mr. Bowles said, is to give the service station operator a break. "He has always had to carry the heaviest part of the job of making gasoline rationing work," he added. "He has to keep the accounts and make the reports we depend on to assure us that gasoline is going where it is needed most. I know that many dealers often work

OIL FOR THE FIGHTING FRONTS—



New Guinea:

Photo at the left shows drums of gasoline being unloaded from a Liberty ship at the docks, "somewhere in New Guinea"

Iceland:

Right, 55-gal. drums of gasoline are being rolled from a ship and loaded onto trucks. The fuel will be distributed later to supply depots all over the island of Iceland

far into the night balancing their coupon accounts and pasting coupons on the sheets that they have to give their suppliers to get gasoline to refill their tanks.

"And now we have told them that they must not take any coupon that is not properly endorsed. We have told them that if they do, they cannot get gas from their suppliers for such coupons, and that their permanent working inventory will be cut by the amount of the unendorsed or otherwise invalid coupons they take in. We have had to make these strict rules for all gasoline dealers, to keep a few dishonest ones from putting the others out of business.

"The filling station men understand this. They do not want the business they are in to turn into a racket. As a whole, they have spared no effort to co-operate with the rationing program and make it work cleanly. But they are shorthanded and busy, as we all are these days. It adds greatly to their burdens to have to hunt a pen or pencil for you to endorse your coupons at the pump, while your car is blocking the driveway."

Lauds Gasoline Dealers

"It is to the credit of the conscientious gasoline dealers of this country," Mr. Bowles remarked, "that, in spite of this pressure, they have cooperated so well to make rationing work cleanly and fairly. More and more, dealers have realized that the endorsement idea provided them their only protection against handling counterfeit or stolen ration currency. Instead of asking OPA to abandon the requirement, they are now asking us: 'why don't you do a better job of enforcing it?'

"And that is exactly what we are going to do, but meanwhile I want to express my personal appreciation to those patriotic citizens for all they have done so far. I want them to know that we do not underrate what they have done to keep rationing out of the hands of the thugs who are trying to move in the business of distributing gasoline and make it a profitable racket for themselves.

"The American filling station, with its motto of service, has always been recognized as a symbol of what is best in the American tradition of free enterprise. It will take more than a bunch of racketeers to destroy that proud record.

"We here in OPA mean to do everything in our power to make it easier for the gasoline dealer to continue to operate his business squarely and without intimidation from gangsters. . . ."

Although it may be a burden to motorists to endorse all their gasoline coupons, Mr. Bowles said OPA's enforcement will spare no effort that is necessary "to see that these coupons are endorsed 100 per cent" so that the indifference of a few individuals will not wreck a rationing program on which "the successful prosecution of the war on the home front depends."

The rule requiring that every coupon handled by a service station must bear the license number of the car from which it came, "is the only sure-fire way" to track down those responsible for leaks in the gasoline rationing system, Mr. Bowles said.

RFC To Aid Vets Revive Own Small Businesses

NPN News Bureau

WASHINGTON—RFC Feb. 28 announced extension of its small business loan program to include loans to service men for the purpose of assisting them in re-establishing business operations upon discharge from military forces.

Former owners of all types of small businesses, including filling stations and bulk plants, will be eligible for assistance. Applicants will be expected to show prior business experience, to have a proper amount of equity capital, and there should appear a sound economic need for the business, according to RFC.

Approximately 85% of small business loans made by RFC during the last 10 years have ranged between $5000 and $25,000.

World Oil—

REVEAL VAST U. S. STAKE IN ARABIAN OIL

(*Continued from p.* 3)

with responsibility of developing a national oil policy. The congressional upheaval over the tax bill veto and the death of Senate Minority Leader McNary were factors contributing to the delay, and the prospect was that way might be cleared for action sometime next week.

Another development saw Navy Secretary and PRC board member Frank Knox writing to Chairman Wheeler of the Senate Interstate Commerce Committee that PRC "does not propose to compete with the private oil industry in this country.

"On the contrary," Col. Knox said, "its purpose is to promote the private oil industry in this nation, and to further the interests of the people of the United States." He added that a "realistic view of the conditions confronting the government demands the existence of some government agency which, working with industry, will be able to study and advise upon steps which must be taken to assure the flow of petroleum supplies to the United States from overseas sources when and as required."

Two Refineries Proposed

The huge size of the Middle East oil development program was disclosed here by representatives of the participating American companies.

As presently outlined, the program contemplates the erection of two refineries at the Mediterranean terminus of the government-owned trans-Arabian pipeline—one of 50,000 b/d capacity to be installed and operated by Arabian-American at a cost of about $62,000,000, and a second of smaller size to be owned and operated by Gulf Exploration Co. Cost of the latter refinery is expected to be from $25,000,000 to $30,000,000.

In addition, Arabian-American will undertake a $50,000,000 exploration and development program in its Saudi concession and invest some $8,000,000 on the construction of a modern, new company-owned city at Ras Tanura, where headquarters will be established.

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World Oil—

OILMEN HIT PIPELINE AS IMPERIALISTIC

(*Continued from p.* 3)

sacrifice for an ally engaged in a life and death struggle with the common enemy."

Offer Comparative Figures

The figures shown in the accompanying table against delivery by tanker alone is the compilation of a dozen experts in the industry representing marine, pipeline and foreign divisions. Costs are computed on the ratio of $4.04 exchange, British pound to U. S. dollar, and on the basis of foreign flag tankers. U. S. flag tankers would raise the costs somewhat. Figures are for a 24-in. line.

The Suez Canal toll of 17c includes handling charges as well as the legal tariff. Explanation of the different rates from the same port to New York lies in the different port charges and the technicalities of handling. Maintenance charges and amortization are included in the over-all pipeline costs to Haifa.

From this table it is clear that the pipeline would not save much more than the Suez toll.

But the total cost picture is not portrayed in the delivery charges alone. When other items are added, oil brought to the U. S. East Coast by the pipeline and tanker route would average out more than the cost of laying down East Texas crude on the East Coast. Cost of the Arabian oil itself is about 10c; there is a 25c a barrel "rake-off" to King Ibn Saud, and at least a 25c differential due to the high sulfur content of the Arabian crude compared with Texas crude.

Arab Venture Unproved

The whole estimate, industry leaders point out, indicates that the Arabian venture is far from being established as a

sound financial operation.

But the second chief protest against the deal raises an even more important issue. One high industry executive here charges that the scheme is "an invasion of the sovereignty of other nations". He points out that such intrusion by a foreign government as the U. S. proposes to undertake has been looked on "with special hostility by many smaller nations".

The project, many industry leaders say, would strain the relations between PRC and any country which it enters and would forestall friendliness, mutual respect and goodwill. Rights to develop oil abroad, it is pointed out, are derived from governments by concession. Such a concession creates many obligations to the nation involved as the concessionaire companies have daily business contacts with the people and government of the country in which they operate. Numerous disagreements arise over royalties, taxes, labor laws, etc. These governmental relations will not be conducted in a spirit of amity, it is said, if the government is a partner of the concessionaire solely for the purpose of showing potential armed support for the concessionaire if the disputes prove critical.

For the U. S. to embark on the Arabian deal, industry leaders generally are beginning to feel, is for the U. S. to commit itself to a policy of imperialism and foreign exploitation, and to push that policy through the enforced assistance of the petroleum industry.

FTC Gives Congress Report On Oil Distribution

WASHINGTON—The Federal Trade Commission has transmitted to Congress Part 4 of its series of reports on methods and costs of distributing important consumer commodities.

Two sections of interest to the oil industry are devoted to exhaustive studies of distribution methods and costs of petroleum products and rubber tires and tubes.

The report is based upon information supplied by manufacturers, chain stores and department stores, reports made to the Bureau of Internal Revenue by wholesalers and retailers and a reservoir of information developed at various times by the commission through its economic and legal investigations of specific industries.

Supreme Court Restrains OPA

NPN News Bureau

WASHINGTON — L. P. Steuart & Bro., Inc., Feb. 28 obtained a temporary Supreme Court restraining order against enforcement of an OPA order restricting its sales to consumers served during the 12-month period ended October, 1942.

At the same time, the court set a March 15 deadline for filing of a writ of certiorari by Steuart. If this is granted, the restraining order will be continued until final determination of the appeal.

CRUDE OIL DELIVERY COST, (Middle East to New York)

	Via pipeline and tanker c in bbls, (42 gal) Saudi Arabia	Abadan		Via tanker only c in bbls, (42 gal.) Saudi Arabia	Abadan
Pipeline to Haifa (including depreciation)	23.0	17.0	To Suez	18.0	19.0
			Suez toll	17.0	17.0
				35.0	36.0
Haifa to New York (T-2 tanker, postwar costs)	34.0	33.0	Suez to N. Y.	35.0	39.0
Delivery cost to N. Y. excluding duty and profit	57.0	50.0		70.0	75.0
5% profit on pipeline	6.0	4.0			
Tanker profit	9.0	9.0			
Total	15.0	13.0		15.0	15.0
Delivery Cost including profit	72.0	63.0		85.0	90.0

World Oil—

Guaranty Survey Views Nation's Oil Problem; Finds Policy Badly Needed, Here and Abroad

NPN News Bureau

NEW YORK—Guaranty Trust Co. of New York, in its monthly survey published Feb. 24 under the title "Our National Oil Problem", says: "Our present supply of oil is conspicuously a product of free enterprise. Nowhere else in the world is to be found such a volume of known reserves or such a scale of development. The system of free enterprise will continue to supply us with liquid fuels and lubricants for a long time to come if it is permitted to do so by a national policy that clearly recognizes the long-term essentiality of petroleum and definitely encourages its discovery, development and efficient production. . ."

Citing the fact that prices of petroleum products have shown a smaller upward swing in the last two years than any other major group of commodities, the survey said: "OPA apparently has failed to recognize that present increased profits are due in substantial measure to the record-breaking volume of production which means that the companies are selling 'goods from the shelf' that cannot be replaced at present cost and price levels. As for the alleged inflationary effect of higher prices, this consideration is not allowed to interfere with the production of airplanes, tanks, ships and guns, which, like the petroleum that powers them, must be supplied irrespective of price if the war is to be won".

Drilling Follows Price Trend

The survey added:

"The deficiency in discoveries during the last few years stems primarily from a price structure which deters extended exploration that would, in the opinion of eminent geologists, uncover the needed oil. Petroleum history shows that price has a direct effect on exploration and discoveries; drilling has followed the same general trends as have prices of crude oil. With adequate prices, exploratory work and drilling are stimulated and risks taken that are shunned in periods of unprofitable prices."

The bank stressed that there is an "imperative need" for a national oil policy.

Commenting on the Arabian pipeline project, the survey said it is still unclear "whether the government intends to go further in competing with private companies."

"An adequate supply of petroleum has become an even more indispensable condition of national security and national welfare than was recognized before the war, and its importance, as far as can now be foreseen, will continue to increase for an indefinite period in the postwar era. The known petroleum reserves of the United States will not supply our needs for more than a comparatively short time and we face the imperative necessity of developing a national oil policy that will assure us of a supply sufficient to meet those needs."

Questions Unanswered

The Near East oil deal leaves unanswered a number of basic questions regarding future oil policy, the survey points out and goes on: "The first of these concerns the industry at home. In view of the alarming condition of our crude oil reserves, the question whether the government intends to take adequate steps to insure the future supply has become urgent. Extensive tests of unexplored domestic areas should be carried out without delay and it seems essential to allow oil prices to rise to a level that would induce such a search.

"There has been some discussion of the possible alternative of subsidies—a device that is abhorrent to most of our citizens, including those in the oil industry. If this is the only remedy the government can propose, nothing worth while will be accomplished and new reserves will probably lag even farther behind than in recent years."

PIPELINES—*Views of the Industry's Problems a*

Washington— *U. S. Facing Major Clash With British on Middle East Oil* —By Herbert Yocom

WASHINGTON—A controversy of major proportions is rapidly building up between this country and the British over what have now become their conflicting oil interests in the Middle East.

Mr. Yocom

The controversy was precipitated by announcement of the PRC Trans-Arabian pipeline deal; it may be brought to an early head as a result of British pressure for materials needed by the Iraq Petroleum Co. to build a new privately - financed 250,000 b/d crude line from Kirkuk to the Mediterranean.

In the midst of the conflict, and not merely bystanders either, are two groups of American companies whose interests are no less at odds—on the one hand, Jersey Standard and Socony-Vacuum, which own a 23.75% interest in Iraq Petroleum, and, on the other, the three principal beneficiaries of the PRC project: California Standard, The Texas Co., and Gulf Oil.

The issues involved are, of course, very real. This government, through PRC, is bound and determined to acquire a large permanent American oil stake in the Middle East, being firmly of the belief that failure to do so would materially weaken the position of the U. S. at the peace table and in the postwar world. There appears to be genuine fear that unless we act now, and quickly, King Ibn Saud may tire of waiting for royalty payments and, by a scratch of the pen, transfer the Arabian oil concession elsewhere—to the British perhaps.

Accordingly, nothing apparently is to be allowed to stand in the way of this Trans-Arabian pipeline deal, not even the wishes or interests of His Majesty's government. It is going to be bulled through, come hell or high water and the British can just sit back and wait until we get good and ready to turn loose the necessary materials for the Iraq project, which has been kicking around PAW's foreign division for half-a-dozen weeks or more already.

As for the British, they see the approaching end of their domination of the Middle East. Uncle Joe Stalin has long since crowded down on Iran from the North and now Uncle Sam is moving in from the south, so naturally they are "concerned profoundly," to quote Foreign Secretary Anthony Eden. Because this American venture does so "deeply affect British interests," to quote Mr. Eden again, they are said to be prepared to take a long and careful look at it before giving it their approving nod, if indeed they ever do.

Thus, George Hill, Jr., appears to have hit the nail squarely on the head when, speaking of the PRC deal, he reported to P. I. W. C. this week that "this is an inter-allied postwar dispute in the very midst of the present war."

* * *

Mexico Report Exaggerated

Published reports this week to the effect that the Army and Navy Petroleum Board plans to build two large crude lines across the isthmus of Mexico from Puerto Mexico to Salina Cruz are not only premature but also greatly exaggerated.

It is true that consideration has been given from time to time to the need for a line across the isthmus, but the proposal is far from being active now. When and if it is ever built will depend entirely on future developments in the war; the adequacy of tanker transportation, etc. and when and if built nothing like the reported fantastic capacity of 500,000 b/d will be provided.

* * *

Error for Rep. Voorhis

New Deal Rep. Jerry Voorhis, of California, was way off base when he tried to pin responsibility for the Trans-Arabian pipeline deal on oil men who had for a time been in the government service and who he accused of dictating the government's policy determinations. What New Dealer Voorhis should have done was to point his suspecting finger first at No. 1 New Dealer Franklin Delano Roosevelt and then at Secretary Ickes, who bows to none in his loyalty to the New Deal banner.

Atlantic Coast— *Fear Arabian Deal Dragging U. S. Toward Imperialism* —By Henry Ozanne

NEW YORK — The rising protest of the petroleum industry against PRC's Arabian oil deal spotlights one of the most crucial issues involved in the whole scheme—U. S. postwar economic imperialism. "Imperialism" always has been an ugly word in diplomatic dealings but it is now finding its way into the public print in connection with the Arabian venture. The conservative *Wall Street Journal* Feb. 25 opened its two-column analysis of the Saudi Arabian pipeline project with these words: "Indications that the postwar policy of the United States will be strongly imperialistic are accumulating."

Mr. Ozanne

It now appears to many industry leaders that the U. S. Government plans to implement postwar "strongarm" tactics with the enforced help of the oil industry, and scores of top company officials are seeing therein a new and great threat not only to their business interests but to the very principles of their own government.

By this time it is generally accepted that the pipeline is not at all a war measure, as it has been justified, but actually a long-range peacetime project. And one high industry official told this writer "such action is the most imperialistic ever undertaken by the U. S., and if such policies are pursued our country appears committed definitely to future wars and to constant maintenance of armed forces all over the world."

Possibility of international hostility over the PRC deal is explained by a number of industry officials and on the following grounds:

Iraq and Iran will take direct affront at the project, blaming the U. S. government for an economic blow at their own interests. As a result they will demand and obtain greatly increased transportation outlets since these governments receive a revenue of 21c to 28c per bbl. on all crude exported. This country will be plunged from the start into a bitter competitive war.

South American as well as U. S. petroleum exports to Europe will be virtually shut off as a result of the stepped-up quantity of oil thrown on the European markets, and difficulties will be created immediately with our South American neighbors. Industry men point out that resentment is much keener when such competition is the result of government intervention than when it is due simply to private company trade practices.

The whole PRC scheme is one imposed on weaker nations; it presupposes a power relationship, these men say. The U. S. has declared itself the "protector" of the rights of Saudi Arabia and Kuwait, and as a result the very countries with whom we are doing business will be our enemies. Sound business dealings assume a relationship of equality that is not existing in the present arrangement. What would we do, asked

one official, if some foreign power proposed to build a pipeline for its benefit across our country? "We'd throw 'em out. The difference in this case is, Kuwait and Saudi Arabia aren't strong enough to throw us out." No government can engage in the oil operations of another country without invading the sovereignty of that country, another petroleum industry leader told this writer.

There is a further threat to amicable international relations in the fact that the U. S. Government would buy a billion barrels of crude at 25% under the market price. Aside from its trade and economic meaning, such an arrangement is a political weapon. It raises a host of other questions: Will the U. S. Government next go into the refining and marketing phases of Arabian oil? Just how does the government intend to use such vast economic power in a political way? Is Washington banking on manipulating the industry to implement state policy?

And throughout all this, many oil men are reminding, we have apparently lost sight of our avowed major goals—the establishment of good business and good diplomatic relations with South America. Oil supplies for any future war will come from places most accessible to our tankers, regardless of ownership of reserves, and that means South America. We could build up huge stores there more readily than we can in the Middle East. South American countries have in the past been mistrustful of "Yankee imperialism" and only by long and careful diplomatic relations have we largely broken down that fear.

Now we are plunging into exactly the sort of deal that will again alienate all Latin America. As one official said, "Don't we yet know who our friends are? The American business man, through the action of his own government, may soon find himself the man without friend any place in the world."

Midwest— *Defective Tanker Tubing Has Effect on Dist. 2 Supplies* —By Earl Lamm

CHICAGO—Serious failure of condenser tubing, which has been laying up the new wartime tankers built by the Maritime Commission as reported in OILGRAM the other day probably accounts in a large measure for the difficulty of obtaining tank cars for shipment of West Texas sour crude to Dist. 2 refiners under the new DSC compensatory plan, as well as for the movement of other crudes and products.

Mr. Lamm

The tanker failure and the increased military demand for products has thrown an over-burden on tank cars. Delay in completing the Litte Big Inch pipeline which might have lightened the load (although products are now on their way through it) has had a deterrent effect.

The tanker trouble was with the use of the Admiralty metal, a bronze alloy, which had to be used in place of copper nickel or aluminum bronze. The substitute metal caused corrosion, due to suction or electrolysis.

The 60 or 90 days needed to complete repairs probably gives a hint as to the period of tightness of tank cars, although it would only be natural if there is a gradual loosening up as more and more of the tankers are put back into service.

This situation has had far-reaching effects. Dist. 3 production was stepped up to provide both more crude and products for Dists. 1, 2 and 5—especially more sour crude from West Texas for Dist. 2 refineries under the new DSC compensatory plan; but the Dist. 2 refiners who would fly at it, have had their wings clipped by lack of tank cars, and Dist. 3 with storage full, is having to cut back production.

However, a Dist. 2 committee has been actively at work compiling rate data and other details for extension of the DSC plan to include importation of crude from other than West Texas fields. The expanded plan already has been approved in principle by PAW and DSC, and it is anticipated that it will be in effect very shortly. Detail rates, etc., which the committee is working up are due to be submitted this week. Extension of the DSC plan immediately is considered of great importance as river barges are being made available and Dist. 2 refiners can obtain crude from Louisiana and the Gulf Coast area. It is understood that Wyoming crude will also be included in the enlarged plan so that movement from there can start as soon as tank cars are available.

* * *

Some Jobbers Losing Suppliers

A curious wartime circumstance is how some independent jobbers in the Midwest are casting loose from their refinery moorings and are floating about, picking up their supplies wherever they can find them. It probably is indicative of the tightening of supplies in one manner or another as military demands build up, preparatory to invasion.

Being without a supplier connection in time of stress is plenty of justification for jobber alarm and the Dist. 2 industry committees are to be congratulated on the manner in which they have spread decreasing supplies among distributors to keep them alive. Being now at the hump in the heating season with refiners sighting the end, it is still tough going for jobbers grabbing at fuel oil straws. The increased shipments of fuel oil, kerosine and distillate to Dist. 1 from this area has not helped matters any here.

For instance, Tony Wiersma of the Sioux Oil Co. at Orange City, Ia., is looking for fuel oil. He is an old Globe Oil & Refining Co. customer, formerly supplied from their refinery at McPherson, Kans., by way of their Council Bluffs terminal. He is still getting a little gasoline from Globe on his old contract which he said does not expire until May but which he has been advised will not be renewed as the Globe's McPherson plant was sold some time ago to the co-op at Kansas City. Balance of his gasoline supplies he is getting from Cities Service, his new connection, as gasoline is apparently more plentiful than fuel oil right now. He was a customer of Globe for six years prior to the refinery sale, he said.

E. F. Ericson of Ericson Oil Co., Howarden, Ia., is another jobber urgently in need of fuel oil as the sale of the National refinery at Coffeyville, Kan., left him without a hook up. He has owned three stations and a bulk plant in Howarden for many years, which he leased to National then operated them as their agent. In that capacity, he had no worries about a source of supply, but on Jan. 1, he said National advised him they had sold out to the Co-op Assn. of America at K. C. so he bought the bulk plant and station inventory of products and now is on his own.

Mr. Ericson also is getting gasoline, but no fuel oil or distillate for tractors and the spring plowing season is almost here. He said when he took over operations Jan. 1, his supplier referred him to the Dist. 2 office in Chicago for supplies in the future and that he was then referred to the co-op at Kansas City, which had bought the National refinery, with the added information that he was supposed to get supplies from the same refinery he had been buying from regardless of who owned it. Mr. Cowden, he said, wrote him saying he had to buy three tank cars of gasoline for each car of tractor fuel or distillate he bought. He said he was new at obtaining supplies and hardly knew which way to turn, although he had been in the oil business for a number of years as manager for National.

The Week's Orders

(Issued Feb. 19-25, 1944, inclusive)

OPA—Office of Price Administration

Prices

GMPR—Rev. SR 14, Am. 92—Used and reconditioned valves — ceilings
Am. 97 — Tank truck rates in Louisiana
Region VIII Order G-3 under 3 (c), Am. 1—Los Angeles (stove oil) "retail establishment"

MPR 88/MPR 510—Semi-official Correction —Error in ceilings on industrial naphthas and solvents.

RPS 88—
Order 23—Diesel Fuel price adjustment for Cosden Petroleum Corp., Big Springs, Tex.
Order 25—Diesel Fuel price adjustment for Durango Oil Co., Cortez, Colo.
Order 26—Price adjustment for Diesel fuel, etc. sold f.o.b. Falls City, Neb.
Order 27—Price adjustment for Diesel fuel, etc. sold f.o.b. Salem, Neb.

MPR 136, Am. 108—Emergency service charges

MPR 465—Official correction of used pressure vessel prices.

Rationing

RO 5C, Am. 105—Installment issuance of rations to farmers; B, C, E, R strips. — Official Correction — Restrictions on transfer of R coupons in Georgia and Florida
Am. 108—Preferred mileage for used automotive parts dealers.

WPB—War Production Board

L-74, as am. 2-16-44—Application for Class B burner form number changed

L-103-b, as am. 2-19-44—Insecticide glass packing quota increased

L-144, as am. 2-16-44—Laboratory equipment authorization form number changed

M-287, as am. 2-22-44—Anhydrous aluminum chloride—rewording of small delivery exemption

P-98-b, Am. 1 to 1-26-44 version—Tool joints require no preference rating
Direction 2—MRO material for use in retail marketing rated AA-3

P-98-e, as am. 2-25-44—Repairers of consumer account equipment given AA-3 rating

Pri. Reg. 3, Direction 5 as am. 2-18-44—Listed chemicals ratings

R-1, Appendix IV—Tire Allotment Plan

Executive Orders

EO 9425—Establishment of Surplus War Property Administration

Dept. of Labor, Wage & Hour Division

Recommendation of Industry Comm. 66—Specific requirements as to posting, etc.

DSC—Defense Supplies Corp.

DSC Rev. Reg. 1, Am. 4—Transportation by War Emergency Pipelines System
Notice to Applicants for Adjustments—Rates governing computation of compensable movements

Gen. Land Office

Circular No. 1568—Extension of 5-year leases

Digest of Week's War-Oil Orders

Office of Price Administration

REVISION OF USED AND RECONDITIONED VALVE CEILINGS—GMPR, Rev. SR 14, Am. 92—50% of another manufacturer's recommended resale price on identical-type new valve offered as fourth alternative ceiling for reconditioned valves. On used valves two alternative methods of pricing added: 25% of original manufacturer's or any other manufacturer's recommended resale price for identical new valve, i.e. published list price less base resale discount (resale sheet) for 10-1 to 10-15-41 period. Issued 2-16, effective 2-21.

LOUISIANA TANK TRUCK RATES—GMPR, Rev. SR 14, Am. 97—Bulk transportation of petroleum products by tank truck in Louisiana (except by common carriers) may be priced according to La. Pub. Serv. Commission rates or GMPR rates, whichever are higher. Issued 2-26, effective 3-3.

LOS ANGELES COUNTY STOVE OIL—GMPR, Am. 1 to Order G-3 under 3(c)—Term "retail establishment" means physical location of store, shop, garage, service station, etc. in which petroleum products are sold at retail other than by tank wagon or larger lot deliveries. Issued and effective 2-11.

ERROR IN NAPHTHA CEILINGS—MPR 88 and MPR 510—OPA has announced that industrial naphthas and solvents were inadvertently priced according to NPN 10-8-41 quotations, instead of March, 1942 prices. Usual prices prevail, and official correction will soon be issued. Announced 2-22.

DIESEL FUEL PRICE ADJUSTMENT FOR COSDEN PETROLEUM CORP.—RPS 88, Order 23—4c gal. permitted Cosden Petroleum Corp. of Big Springs, Texas, at bulk plant in Monument, New Mexico, for Diesel fuel loaded into buyers' tank wagons or transport trucks. Issued and effective 2-12.

DIESEL FUEL PRICE ADJUSTMENT FOR DURANGO OIL CO., CORTEZ, COLO.—RPS 88, Order 25—11.5c gal. delivered to consumers in Cortez and Dove Creek, Colo., 12.5c in Monticello, Utah, and 13.5c in Blanding, Utah. Issued 2-16, effective 2-12.

ADJUSTMENTS OF CEILINGS ON FUEL OIL SOLD F.O.B. FALLS CITY, NEB.—RPS 88, Order 26—Mid-States Oil Co., Falls City, Neb. permitted following prices per gal., f.o.b. Falls City: tractor fuel (hot) 56-58 gravity, 450 end point—6c; No. 1 fuel oil or distillate—5c; Diesel fuel, 58 Diesel index and above—5c. Issued 2-16, effective 2-21.

ADJUSTMENTS OF FUEL OIL CEILINGS F.O.B. SALEM, NEB.—RPS 88, Order 27—Nebraska Producing & Refining Co., Salem, Neb. permitted following ceilings, f.o.b. Salem: tractor fuel (hot) 56-58 gravity, 450 end point—6c gal.; Diesel fuel, 58 Diesel index and above—5c; kerosine, 40 A.P.I. gravity and above—5½c. Issued 2-16, effective 2-21.

MPR 136, Am. 108—Extra costs resulting from purchase of materials (not including parts and subassemblies) in an emergency, at customer's request, may be added by manufacturers and machinery service suppliers. Extra transportation costs resulting from emergency shipping (including parts) may also be added, both without markup or profit. Extra charges must be separately entered on invoice, and copy of invoice forwarded at once to OPA Machinery Branch, Washington. Special rules added for determination of ceilings on machines and parts containing domestic, Treasury, or foreign silver. Issued 2-21, effective 2-26.

SALES TO GOVERNMENT—MPR 136, Am. 109—Sales of secondhand machines or parts to Government may be accompanied by written certificate of inspection, signed by qualified disinterested person, instead of usual guarantee. Issued and effective 2-23.

CORRECTION OF USED PRESSURE VESSEL PRICES—MPR 465, Official Correction—13 prices listed in Appendix A for reconditioned and guaranteed, as well as "as is" vessels, corrected in amounts varying from $600 (due to typographical error) to $2. Issued 2-22, effective 2-28.

ISSUANCE OF GASOLINE RATIONS IN INSTALLMENTS TO FARMERS—RO 5C, Am. 105—B, C, E, and R coupons to be issued in strip form, bearing consecutive serial numbers. Folders will bear notations formerly appearing on ration book covers, as well as serial numbers issued. Transferors must ascertain that serial numbers of coupons accepted are within range of notation on folder. All or part of 6-month non-highway ration for farming may be issued, on request of applicant, to promote better estimate of need and prevent over-issuance. Issued 2-21, effective 2-25.

Official Corr. to Am. 105—In Georgia and Florida R coupons may be honored only when dealer or distributor transports gasoline, by his regular facilities, in quantities over 25 gals., to destination selected by transferee. Motorboat fuel tanks are excepted. Issued and effective 2-25.

PREFERRED MILEAGE FOR USED AUTOMOTIVE PARTS DEALERS—RO 5C, Am. 108—Regular dealer in used automotive parts eligible for extra gasoline rations for travel necessary to accumulate such parts, upon presentation to Ration Board of WPB Regional Automotive Representative certificate of essentiality. Issued 2-28, effective 3-3.

These digests of orders, amendments and interpretations are written with care and judgment for the purpose of giving the reader a reasonable idea of the character and extent of this material, but the publisher does not warrant their completeness or absolute technical or legal accuracy. Important decisions should be made only after due study of the complete text, which the Oil-LAW-Gram can furnish.

NPN will appreciate hearing from its readers if they feel any pertinent regulations have been omitted from this page.

Copies of the complete text of the following orders can be obtained from PLATT'S OIL-Law-GRAM, 1213 W. Third St., Cleveland, Ohio.

Minimum charge for single copies, $1, postage paid. One year's service, $100.

CODE: AO—Administrative Order; CMP—Controlled Materials Plan; D—Directive; FDO—Food Distribution Order; GMPR—General Maximum Price Regulation; GO—General Order; Interp.—Interpretation; L—Limitation Order; M—Conservation Order; MPR—Maximum Price Regulation; P—Preference Rating Order; PAO—Petroleum Administrative Order; Pri. Reg.—Priorities Regulation; Proc. Reg.—Procedural Regulation; PS—Price Schedule; RO—Ration Order; RPS—Revised Price Schedule; SO—Supplementary Order; SR—Supplementary Regulation.

War Production Board

APPLICATIONS FOR CLASS B BURNERS—L-74, as am. 2-16-44—Form WPB-1319 is now used for WPB approval of applications for Class B oil burners. Issued 2-16.

INSECTICIDE GLASS PACKING QUOTA INCREASED—L-103-b, as am. 2-19-44—Fungicides, insecticides, etc. calendar year glass packing quota now 150% of 1943. Only new pint containers and smaller included. Issued 2-19.

LABORATORY EQUIPMENT — L-144, as am. 2-16—Authorization of purchase of laboratory equipment now effected on Form WPB-1319. Issued 2-16.

ANHYDROUS ALUMINUM CHLORIDE—M-287, as am. 2-22-44—Suppliers' small delivery (600 lbs.) exemption provision reworded to emphasize that supplier's knowledge or belief as to non-eligibility of customer must prevent delivery. Issued 2-22.

TOOL JOINTS ADDED TO SCHEDULE A—P-98-b, as am. 1-26-44—Tool joints now require no preference rating. Issued 2-24.

SPECIAL MRO RATING FOR RETAIL MARKETING—P-98-b, Direction 2—Petroleum operators now entitled to AA-3 rating for materials for maintenance or repair of retail marketing facilities. Issued 2-25.

MATERIALS FOR REPAIR OF CONSUMER ACCOUNT PETROLEUM EQUIPMENT—P-98-e, as am. 2-25-44—AA-3 rating and allotment symbol MRO-P-98-e may now be used by repairers to get material for maintenance and repair of petroleum equipment used by consumer accounts. Issued 2-25.

LISTED CHEMICALS RATINGS—Pri. Reg. 3, Direction 5 as am. 2-18-44—AA-1 and AA-2 blanket MRO ratings for listed materials; production materials ratings substituted, if available; otherwise Direction 5 assigned ratings apply, except that blanket ratings may be used when a P-98-b rating is applied with symbol MRO-P-3. AA-1 blanket MRO ratings reduced to AA-2X for listed chemicals; AA-2 to AA-3 for listed materials. Materials specifi-

(*Continued on p.* 40)

Our Now Independent Congress Might Find Out Why We Seek Socialized Oil in Asia Instead of Nearby!

THE CURRENT REBELLION of more than two-thirds of Congress against White House dictatorship, which was accentuated and supported by the belated declaration of personal freedom by Democratic Senate Leader Barkley, may mean that the government will not get into the oil business. It may further mean that where the government is in the oil business, due to the alleged needs of war, it will get out entirely in favor 100% private enterprise.

And it may further mean that PAW Ickes' "contract in principle" with several American oil companies to build pipelines in Arabia when, as and if many other things happen, will remain just a declaration by a handful of New Dealers of their hope to put the government into the oil business.

The congressional rebellion indicates that Ickes Arabian pipeline scheme and any additional plans the Administration may have to hook up those lines and the crude they will supply in large quantities to all the other existing "war" oil facilities, will unquestionably get a thorough overhauling by the forthcoming investigation. The rebellion also indicates that the government backers of these lines may try to rush their scheme through to final commitment, if they can, ahead of congressional disapproval. The president can do so many things under his so-called and much inflated "war powers" and under lend-lease law by which he has access to an almost unlimited amount of money that it is conceivable that he will bull ahead on the Arabian deal, if he can.

That the good faith of the Administration in trying to put over this Arabian deal may well be challenged is shown by a consideration of some of the reasons advanced for the deal. It is said—

THAT we do not have enough oil reserves for another war;

THAT our present oil supplies—and POSSIBLE reserves—are dwindling too rapidly for our civilian requirements;

THAT having government money invested in a foreign oil field will insure the government taking a more active and effective part in (a) dealing with England or other foreign governments seeking oil, (b) in dealing with the Arabian and other Near-East governments where the oil exists, and (c) "insuring" supplies for future wars.

As to the first and second reasons, neither the oil industry nor the government know whether we have unfound oil fields in this country sufficient for peace or war time, and no one will know until and unless this Administration, and future ones, permit the oil industry to have the price, the fair tax depreciation allowances and the freedom from unnecessary government interference, to continue to search for those fields. Certainly the policies of the New Deal have definitely worked against the oil industry's getting the necessary supplies, even for this war, and have brought about this present oil shortage. While the oil industry can only prove it with the drill, nevertheless it has good reason to believe that there are still large undiscovered oil producing areas and horizons in this country.

As to the third set of reasons given in defense of the government putting taxpayers' money into Arabian oil pipelines, two things can be said:

ONE: If this government of ours will only support diplomatically its own socialized foreign enterprises but will leave privately-owned American oil companies to shift largely for themselves, as this and some previous administrations have, then congress and the people should say what this government should foster and stand for, private enterprise in foreign lands or American socialized ventures.

If Congress and the people decide that they want private American enterprise abroad and that they want this government to support such enterprises, then Congress should see that this and all subsequent administrations do an intelligent, fair and courageous job of protecting American business enterprise in foreign lands which this and some previous administrations certainly have not done.

The plea that this government can do a better diplomatic job if it owns the foreign properties is a confession of its own lack of interest in the principle of private enterprise and a damaging admission as to why it has left American oil companies largely to fend for themselves or even, as report has been heard, helped "people's movements" in foreign countries to attack American oil companies. If this Administration expects to do an honest and fair job of "horse trading" with the British or the Sheiks of Arabia because it owns a few hundred millions of dollars of property in foreign lands, then this administration can trade just as vigorously and honestly for private American oil companies, if this Administration wants to.

As to the second point raised by the proponents of this government making a large investment in Arabia or other foreign land in order to "have the oil for the next war", the plain fact is that it is not who owns the oil but who can and does keep open the lanes of transportation from those fields to America or wherever the oil is needed. These same British interests—private and government—whose example the proponents of this pipeline deal would allegedly follow, owned and operated large oil fields in the far Pacific. But we now know that the British government's interest in those fields as against 100% private interest had nothing to do with their being lost to Japan. We have no doubt the British government would have kept full access to those oil fields if it could have, regardless of who owned them, so that the British and the Allies could get the oil.

If this country must look to far-off Arabia for its next large peacetime oil supply and for its next war requirements, then it is not a matter of whether this government invests dollars in the oil fields or their facilities. The question is will this government have the war strength and use it to see that the oil comes to this country or wherever we want it sent? In the next war, if there is another, just as in this war the chances are the fighting nations will stand on still less ceremony as to who owns what. We cannot conjure up a picture of Hitler, Mussolini or the Japs not seizing Arabian oil fields just because the U. S. owned a few miles of pipe in them, if those dictators really needed and thought they could get the oil.

If this administration believes there will be another war for which we cannot get enough oil in this country, then would it not be wise for it to plan to get that oil nearer home? In Mexico, and Central and South America? Especially around

READERS' comments and opinions will be much appreciated by Warren C. Platt, NPN's Editor and Publisher, Penton Building, Cleveland 13, Ohio.

the shores of the Caribbean and the Gulf of Mexico? Here is tremendous oil country discovered and partly developed by private American and some British enterprise.

Private enterprise knows there are almost unlimited supplies of oil in this hemisphere and it is willing to develop them, especially if the American government will see that private enterprise is protected in its rights.

In fact, Congress might well ask just why is our Petroleum Administrator going so far away as Asia for oil? Is it to distract attention from any lend-lease and Good Neighbor enterprises below the Rio Grande? That $45,000,000 refinery and pipeline project for Mexico City, started by a couple of high Democratic politicians, has been kept just about as secret as Ickes tried to keep the Arabian deal? What else is the government up to with our good neighbors in regard to oil? Or is the administration trying to keep congress from finding out how incompetent and shameful its oil diplomacy in this hemisphere has been in behalf of private American enterprise?

A free and independent acting congress, such as we now have evidence of, is much needed to clear up just what it is this administration has been up to in oil, and oil socialism, and what this administration now is trying to do, publicly and privately, in regard to oil and oil socialism?

How PAW in Dist. 2 Enlists Everyone's Aid

GOVERNMENT WAR AGENCY co-operation with industry as it should be, was again well exemplified at the annual meeting of Iowa Independent Oil Jobbers Association at Des Moines last week. As one watched this meeting one could not help but wonder how much farther along in this war effort our country would be, if all government agencies had always been as intelligently considerate and co-operative.

In marked contrast to the period before the present chief rationing officer Col. Bryan Houston, and particularly in contrast to the days of OPAer Leon Henderson, were the remarks and the attitude of E. F. Stegen, chief rationing officer for OPA at Chicago. He talked sense, he showed his mind is open to reason, and he did not indicate that he was there with omnipotent authority and that his audience were just peasants subject to his every command. In fact, in the discussion of how to improve rationing he showed he wanted the help of the oil men and they showed he would get it.

All of this is in great contrast, so some with long memories said, to similar meetings some of which included this same Rationer Stegen a year ago.

And as one noted the cordiality of this OPA man and his warm reception, one could not help but speculate on the amount of good-will that has been built up the past eight months for PAW by the personal efforts and contacts of Director Vandeveer and his associates of PAW Dist. 2 at Chicago.

When Director Vandeveer took over Dist. 2 last summer he at once began a series of what he called "grass root" meetings. He did not have to call them because he let all existing oil associations in his 15-state district know that he would like to attend their meetings and tell them what he was trying to do and to get their advice as to how to do it. The result was that to date Mr. Vandeveer has talked to 17 groups of oil men and has made two radio talks to the public in his district and he is scheduled to appear before five more such oil meetings in the next two months. Of these meetings 12 were the annual gatherings of that number of state independent jobber associations, the men who personally have the most to do with PAW and other government regulations in marketing and the men who were given the least representation on the various interested committees.

While Mr. Vandeveer has to read an official speech that has been duly approved by censors at Washington, he answers frankly a host of questions.

He is supported by three assistants who always accompany him and two of whom talk, Ernest L. Hughes, as marketing director and Harry Nankervis in charge of manpower problems. Philip D. Denton, publicity man and special assistant, is also along but does not make talks. Messrs. Vandeveer, Hughes and Nankervis are independent oil marketing men so their handling of questions is as one oil marketer to another.

Unlike so many other war agency men, especially those lately in OPA, these three government oil men begin their remarks by assuring their audience that they do not like government regimentation, that they would not stand for it, let alone be a party to it, if it were not for the war, that the thing is not perfect and never can be, and that they hope to end their part of government regulation and go back home the minute the last gun is fired, if not sooner. And they make it plain that the only way these regulations can be made to work is by every man in the oil industry understanding them and their necessity and each doing his best to make them work for the success of the war.

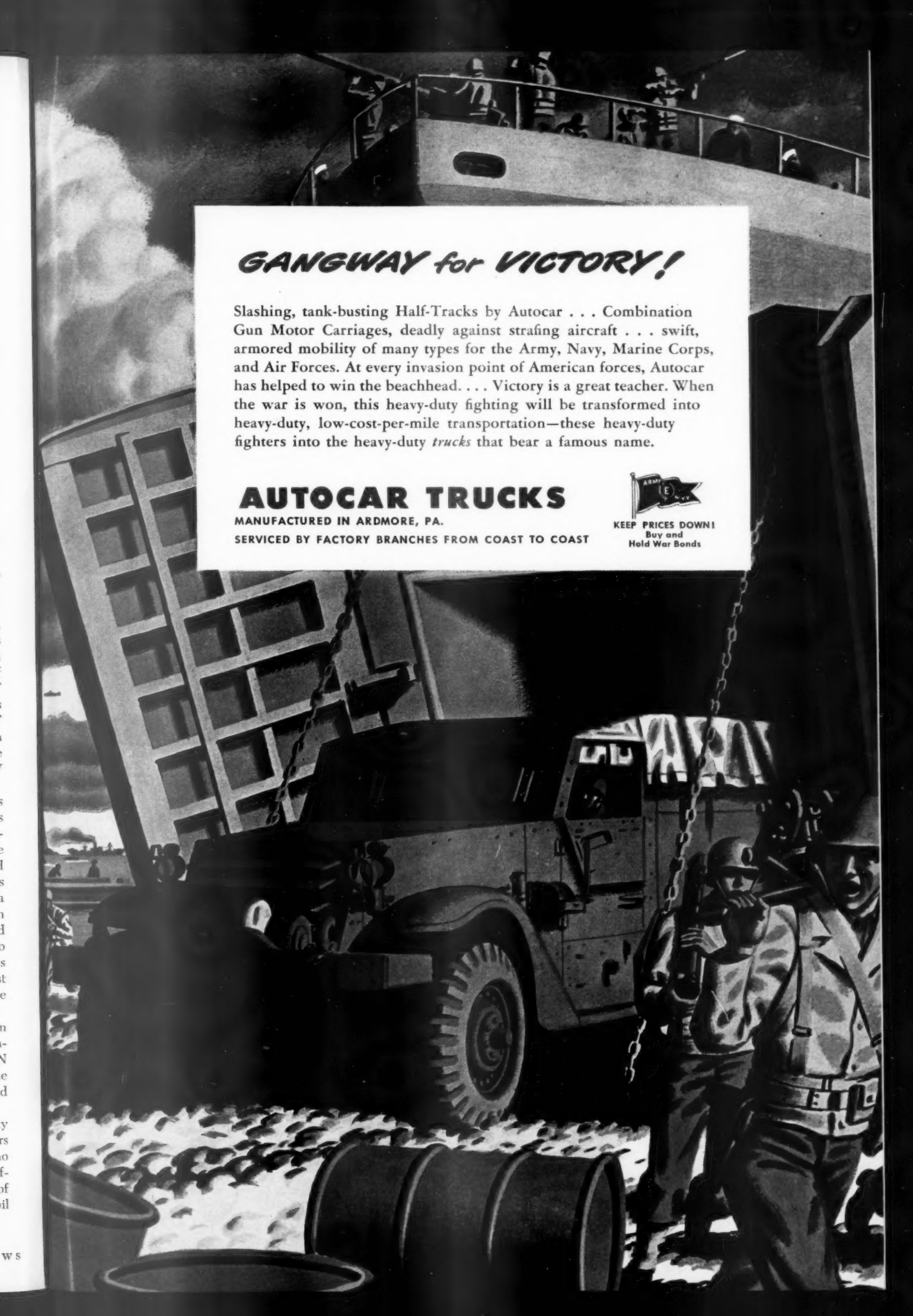
How different is this attitude from the lordly manner with which so many other war agency and government men, including the military departments and the White House, seek to "command" and scold "the people—" especially those in business.

We say these things about the job that Messrs. Vandeveer et al are doing in Dist. 2, not unmindful of the good work of directors of other districts but because Dist. 2 has the largest number of independent jobbers—more than 7000 of the 11,000 in the country—and because these jobbers are well organized and have been accustomed to fight for their rights. Also, the contrast is all the more marked in this district, between OPA of the past and PAW, because it was largely the jobbers in this district who made the fight that resulted in Leon Henderson being fired from OPA. Henderson was one of many in Washington who did not think any "common man" had any rights, especially when the latter disagreed with his views. These, our readers may recall, were called "pro nazi" by Henderson and he sic'd the FBI, like the Gestapo, upon them. Probably more investigations, and law suits against the larger oil companies have originated in what is now PAW Dist. 2, including the more recent Madison cases.

At the moment PAW Director Vandeveer is assuring his audiences that he personally will guarantee that the hardships of the increasing oil shortage will be spread as fairly as possible and that if there must be a directive parceling out the small supply, that directive will be just in the first place and will be fairly and impartially enforced in the second. To this end, Mr. Vandeveer tells his audiences, the plan for such a directive is now being developed by industry committees in the district and that as soon as a final draft has been handed to him and before he passes on it, he will broadcast it to every one in the district for their opinion. He assures his hearers that nothing will be cooked up in the dark against them and that the independent oil man will get exactly the same deal as the majors.

It is unfortunate that the committees who are their own bosses, have not taken the rest of the industry into their confidence as to what they are now working on, though NPN and OILGRAM have quite accurately reported, without the aid of these committees, the essence of their discussions and agreements so far.

An observer may well say that PAW Ickes and Deputy PAW Davies are most fortunate to have handling PAW affairs in this independent thinking and acting area, these men who do not forget that they, too, are just ordinary oil men no different in heart, brains or business, from many thousands of oil men with whom they must co-operate to make our oil war regulations work.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Sound Financial Structure of Oil Industry Lauded In Pogue-Coqueron Report on 9-Year Study

NPN News Bureau

NEW YORK—One of the most detailed financial analyses ever made of the petroleum industry has just been completed by Dr. Joseph E. Pogue, vice-president of the Chase National Bank, and Frederick G. Coqueron, department of petroleum economics of the Chase National Bank. The analysis is entitled "Sources, Disposition and Characteristics of the Capital Employed by 30 Oil Companies During the Nine-Year Period 1934 to 1942". It is set forth in booklet form of 37 pages, with 14 tables and 13 charts and graphs and was presented before the Petroleum Division of the American Institute of Mining and Metallurgical Engineers in New York Feb. 24.

The conclusions which Dr. Pogue and Mr. Coqueron reach are summed up under 14 topical headings:

1. The petroleum industry generates the capital needed for its expansion almost entirely from its own operations and is therefore a singularly self-contained economic unit.

Analyze Sources of Funds

The sources of industry funds are classified as internal—net income, capital extinguishments; etc.—and external—net changes in long-term debt and preferred stock, and from issuance of common stock. The authors show there is an almost exact balance between the sum of net income retained in the business and capital extinguishments, on the one hand, and capital expenditures on the other. The difference for the 9-year period reviewed is only $147,000,000, the supply of internally-generated funds falling short of capital needs by only that amount, 2%.

2. The long-term debt contained in the financial structure of the industry is smaller relative to the total capital employed, is less than the net working capital, and has increased but slightly during the period under review.

Crude Investment Trend Down

In that time the long-term debt of the 30 oil companies increased $240,000,000 while preferred stock decreased $142,000,000. On Dec. 31, 1942, of the total borrowed and invested capital, $1,100,000,000 was long-term debt of which 51.8% was borrowed from the public; 18.7% from insurance companies; 13.4% from banks; 3.7% from government agencies; 12.4% from other sources.

3. The capital expenditures of the 30 companies for 9 years amounted to 6.1 billion dollars, 58.3% of which went into crude oil producing facilities. The trend of this segment of expenditures has been downward since 1937. In 1942 expenditures for refining facilities increased sharply and for marketing facilities declined drastically.

For each dollar of gross operating income, the 30 oil companies in the 9-year period expended 15.9 cents for properties, plant and equipment. This proportion varied widely among the different groups of companies. For 9 producing companies the relative expenditures were 43.3 cents; for 4 companies with production averaging in excess of refining requirements, the amount was 22 cents; while for 17 companies with refinery throughput in excess of crude production, the figure was 15.1 cents.

4. The net working capital of the group increased $380,000,000 over the period and the industry is in a favorable position of liquidity. The ratio of combined current assents to current liabilities was 3.21 at the close of the period.

5. The net income of the group displayed an upward trend for the period but with rather sharp cyclical fluctuations.

Dividend Payments Low

6. In 1942 Government funds entered the industry for the first time in substantial amounts and were utilized for the provision of war facilities needed for emergency use. In 1942 the 3C companies borrowed $65,000,000 from Government agencies.

7. The group has paid out a relatively low percentage of net income in the

Combined Income Statement of 30 Oil Companies by Years, 1934-1942

In Millions of Dollars

	1934	1935	1936	1937	1938	1939	1940	1941	1942	Total 1934-42	Average 1934-42
Gross Operating Income	3,458	3,707	4,162	4,722	4,344	4,088	3,967	4,744†	5,161†	38,353	4,261
Costs, Operating, & General Expenses*	2,823	2,969	3,242	3,569	3,479	3,190	2,987	3,458	3,957	29,674	3,297
Operating Income	635	738	920	1,153	865	898	980	1,286	1,204	8,679	964
Depreciation, Depletion, Amortization, etc.	430	450	465	503	514	512	531	534	539	4,478	498
Net Operating Income	205	288	455	650	351	386	449	752	665	4,201	466
Non-Operating Income (Net)	68	85	95	104	95	83	104	114	71	819	91
Income before Other Deductions	273	373	550	754	446	469	553	866	736	5,020	557
Less: Interest & Discount on Debt	48	39	32	30	32	36	36	33	35	321	36
Extraordinary Charges & Other Deductions	13	19	14	22	21	32	29	76	41	267	29
Net Income before Provision for Income Taxes	212	315	504	702	393	401	488	757	660	4,432	492
Less: Federal Income & Excess Profits Taxes, State & Other Income Taxes	31	36	61	85	58	52	86	197‡	234‡	840	93
Net Income before Minority Interests	181	279	443	617	335	349	402	560	426	3,592	399
Less: Portion Applicable to Minority Interests	24	26	31	44	35	28	25	30	22	265	30
Net Income Accruing to Companies	157	253	412	573	300	321	377	530	404	3,327	369
Less: Preferred Dividends Paid	11	10	24	14	14	13	13	10	10	119	13
Common Dividends Paid	117	109	209	275	185	175	196	241	212	1,719	191
Net Income Retained in Business	29	134	179	284	101	133	168	279	182	1,489	165
Operating Income vs. Gross Operating Income	18.4%	19.9%	22.1%	24.4%	19.9%	22.0%	24.7%	27.1%	23.3%	22.6%	—

Distribution of Dollar Income

	1934	1935	1936	1937	1938	1939	1940	1941	1942	Average 1934-42
Total Income§	100.0c	100.0c	100.0c	100.0c	100.0c	100.0c	100.0c	100.0c	100.0c	100.0c
Costs, Operating, & General Expenses	80.0	78.3	76.2	74.0	78.4	76.5	73.4	71.2	75.6	75.7
Depreciation, Depletion, Amortization, etc.	12.2	11.9	10.9	10.4	11.6	12.3	13.0	11.0	10.3	11.4
Interest & Discount on Debt	1.4	1.0	0.8	0.6	0.7	0.8	0.9	0.7	0.7	0.8
Extraordinary Charges & Other Deductions	0.4	0.5	0.3	0.4	0.4	0.8	0.7	1.5	0.8	0.7
Income & Excess Profits Taxes	0.9	0.9	1.4	1.8	1.3	1.2	2.1	4.1	4.5	2.2
Minority Interests' Share	0.7	0.7	0.7	9.0	0.8	0.7	0.6	0.6	0.4	0.7
Net Income Accruing to Companies	4.4	6.7	9.7	11.9	6.8	7.7	9.3	10.9	7.7	8.5
Preferred & Common Dividends Paid	3.6	3.1	5.5	6.0	4.5	4.5	5.2	5.2	4.2	4.7
Net Income Retained in Business	0.8c	3.6c	4.2c	5.9c	2.3c	3.2c	4.1c	5.7c	3.5c	3.8c

Notes: * Includes taxes other than income and excess profits taxes, and excludes reserves for depreciation, depletion, amortization, and retirements.

† Includes 45 million dollars and 155 million dollars respectively, representing revenue derived from shipbuilding business. If eliminated in both years, 1942 gross operating income compared with 1941 would show an increase of 6.5 per cent.

§ Includes gross operating income and non-operating income (net).

‡ Analysis of income and excess profits taxes:

	1941 Mill. Dolls.	1942 Mill. Dolls.
Federal Income Tax	162	168
Federal Excess Profits Tax	11	46
State and Other Income Taxes	24	20
Total	197	234

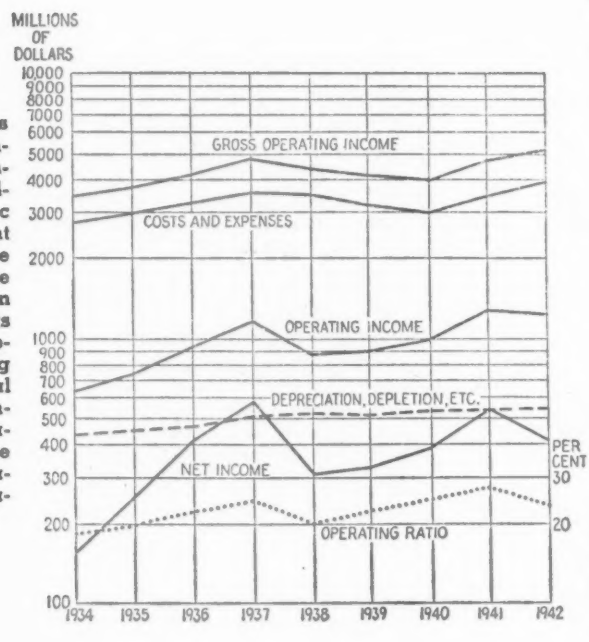
Estimated Cost of Replacing Developed Crude Oil Reserves in the United States by Years, 1937-1942

	1937	1938	1939	1940	1941	1942	'37-'39	'40-'42	'37-'42
	In Millions of Dollars								
Combined Capital Expenditures for Production Facilities by 30 Oil Companies	530	393	357	353	413	327	1,280	1,093	2,373
Less: Expenditures for Facilities located outside of United States	115	57	55	36	30	29	227	95	322
Sub-Total	415	336	302	317	383	298	1,053	998	2,051
Add: Estimated Expenditures for Lease Rentals; Land, Geological, & Geophysical Expenses; & Overhead†	47	44	51	56	58	65	142	179	321
Total Expenditures by 30 Oil Companies	462	380	353	373	441	363	1,195	1,177	2,372
Net Crude Oil Production of 30 Oil Companies in Per Cent of Total Net United States	52.8%	51.3%	51.4%	52.4%	52.5%	53.8%	51.8%	52.9%	52.4%
Indicated Cost of Replacing Developed Crude Oil Reserves in United States by the Petroleum Industry‡	875	741	687	712	840	675	2,303	2,227	4,530
	In Millions of Barrels								
United States Crude Oil Production	1,279	1,214	1,265	1,353	1,402	1,387	3,758	4,142	7,900
Add: Increase in Proven Reserves (As estimated by A.P.I.)	2,444	1,841	1,135	542	564	494	5,420	1,600	7,020
Total New Oil Developed (Gross)	3,723	3,055	2,400	1,895	1,966	1,881	9,178	5,742	14,920
Total New Oil Developed (87.5% of Gross)	3,258	2,673	2,100	1,658	1,720	1,646	8,031	5,024	13,055
Estimated Average Cost of Replacing a Developed Net Barrel of Crude Oil in United States	26.9c	27.7c	32.7c	42.9c	48.8c	41.0c	28.7c	44.3c	34.7c

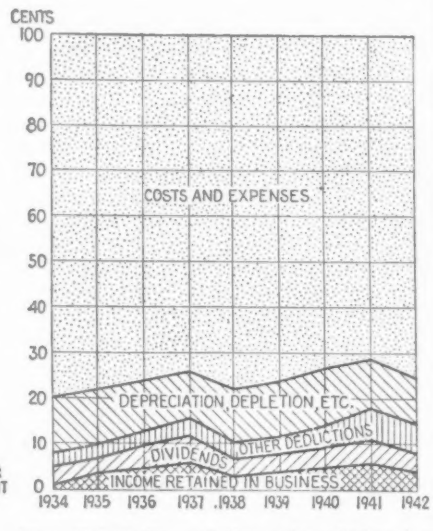
*Expenditures represent gross additions to fixed asset accounts, including cost of undeveloped and developed leases, drilling and equipping wells, and lease facilities; and items charged to income account, such as intangible development costs of producing wells and dry holes, and lease purchase costs.

†Estimated by Dept. of Petr. Econ., Chase National Bank, based on reports published by U. S. Tariff Commission and Petroleum Administrative Board on cost of producing crude oil. Average rates per net barrel were as follows: 1937-38, 8.0c; 1939-41, 9.0c; and 1942, 10.0c.

‡Derived by raising the "total expenditures of 30 oil companies" to an aggregate for the entire industry on the basis of the ratio of the group's crude oil production to the total crude oil production of the United States.



The Trend of key items in the combined income of 30 oil companies by years, 1934-42. Semi-logarithmic scale. Note important bearing upon oil income of slight changes in the difference between gross income and costs and expenses; the upward trend in operating income; the cyclical characteristic of net income; and the correlation between net income and the operating ratio. For data see Table on p. 19



The distribution of the sales dollar for 30 oil companies by years, 1934-42. Note the small proportion of gross income left as net income, and the division of the latter between dividends and income retained in the business. For data see table, p. 19

form of dividends. For the period the average was 55% of net income.

8. The rate of return on invested capital averaged 6.4% compared with an average of 8.8% for a group of more than 1100 manufacturing companies. Integrated oil companies showed a lower rate of return than producing companies.

9. Combined net assets for the group totaled more than 6 billion dollars at the end of 1942, of which $700,000,000, or 12%, were located outside the U.S.

10. The combined net investment in properties, plants and equipment of the group at Dec. 31, 1942, was distributed as follows: production, 45.6%; transportation, 13.7%; refining, 19.8%; market-

(*Continued on p. 34*)

U. S. Government Funds in American Petroleum Industry

	Government Loans for Private Facilities		Gov. Owned Facilities Privately Operated	
	30 Oil Companies	Other Oil Companies	30 Oil Companies	Other Oil Companies
	Mill. Dolls.			
Aviation Gasoline Plants*	192†	63†	28	128
Oil Pipe Lines	...	..	189	
Synthetic Rubber	(633)‡			
Tankers, Barges, etc.	(?)§			

*The private and public expenditures for aviation gasoline plants in 1942, 1943, and 1944 (scheduled) are reported as totaling 900 million dollars.

†The cost of these combined facilities is reported to be 396 million dollars of which 255 million dollars, or 64.4 per cent, represent loans by the Government.

‡No information available for determining allocation to petroleum industry, rubber industry, and chemical industry.

§Data not available.

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REFINING NEWS and TECHNOLOGY

Briefs from Week's News

Toluene Plants Contribute To 100-Octane Program

NPN News Bureau

WASHINGTON—All 15 plants in the Army Ordnance Department's toluene program are now contributing toluene for use as blending agent in manufacture of 100-octane aviation gasoline.

Substantial quantities of toluene are currently being released from each of following plants as a result of recent contract modification made by Ordnance:

Baytown Ordnance Works, Baytown, Tex.; Continental, Ponca City, Okla.; Gulf, Philadelphia; Magnolia, Beaumont, Tex.; Pan American, Texas City, Tex.; Pure Oil, Toledo, Ohio; Shell, Houston, Tex., Wilmington, Calif., and Wood River, Ill.; Sinclair, Marcus Hook, Pa.; California Standard, Richmond, Calif.; Indiana Standard, Whiting, Ind.; Louisiana Standard, Baton Rouge, La.; The Texas Co., Lockport, Ill.; and Union Oil, Oleum, Calif.

Fact that toluene can be delivered from explosives to 100-octane program illustrates extreme flexibility of modern refining operations, PAW said.

Houdry Expands Laboratory

Special to NPN

LINWOOD, Pa.—Laboratory facilities of the Houdry Process Corp. are being expanded with additions of floor space to the main research laboratories of the Catalytic Development Corp. here. Eugene J. Houdry said:

"The continuing research into the catalytic transformation of petroleum has brought about the essential need for increasing our research facilities. The new extension will permit additional working space to accommodate chemists, technicians, engineers and assistants. Upon completion, most of the corporation personnel will be headquartered at the Linwood laboratories."

Deferment Ban May Extend to 22-25 Age Group; Technical Staffs Likely to be Hard Hit

NPN News Bureau

WASHINGTON — National Selective Service headquarters is considering greatly restricting draft deferments for men between 22 and 25 years old, as it has for men between 18 and 21, to provide more younger men to fill draft board quotas.

Branches of the petroleum industry which would be most affected are refining and exploration-production, but PAW is prepared to urge deferment of men within this age group engaged in critical occupations in the two branches if it can be shown that they are absolutely essential to continued war operations.

Men most likely to be hit by the proposed change would be research and development laboratory workers, chemists, chemical engineers, geophysicists, and other technical service groups.

Effect Otherwise Negligible

Aside from the refining and production branches, the effect of further restrictions on deferments for 22 to 25 year-olds would be negligible, it is estimated by oil manpower officials, since in transportation, distribution and marketing most of these men have already been drafted.

As an example of how PAW may step in to request deferments of key men in refining is the case of a 100-octane project, newly constructed, and staffed entirely with fresh personnel of which say four key men are 25 years old and two are a year or two older.

In such a case, it is recognized that loss of all these men could easily cripple the refinery's operations for an appreciable time. But PAW would probably not be successful in obtaining deferment for a man in such a position, 25 years old, who was not a pre-Pearl Harbor father. It is emphasized that single, or childless men between 22 and 25, even though in a critical refining or producing occupation, will be given very little consideration for deferment.

PAW Assistance Limited

In the case of men 22 to 25, engaged in critical occupations in refining and producing branches, who are pre-Pearl Harbor fathers, PAW can be expected to assist companies on matters of deferment, under certain circumstances.

It will be necessary for the company to allow a complete investigation of its personnel problem in the occupational groups affected. It will also probably be necessary for PAW to request WMC's Bureau of Manpower Utilization to make a survey of the plant involved, with a view to certifying to the state director of Selective Service that registrants, for whom it is desired to file Forms 42-A (special), are employed in a critical occupation and utilizing their skills to the fullest extent.

In the case of men 18 to 21, local boards have been specifically instructed not to place any registrant in Class 2A or 2B, subsequent to Feb. 1, unless such a Form 42-A (special), approved by a state director, is on file with them. This will apply to men between 22 and 25, if SS's Local Board Memorandum 115 is amended, as is now under discussion.

Gillette Group Plans Study Of Alcohol as Motor Fuel

NPN News Bureau

WASHINGTON—In a speech on the Senate floor lauding Senator Gillette's leadership in bringing to the front importance of alcohol in synthetic rubber, Senator Willis, Ind., said he would introduce a resolution asking for extension of committee's authority and an appropriation of $3500 to carry on its work.

"A new subject to which the committee has already given some attention is the utilization of alcohol as a motor fuel," Sen. Willis said, adding that "the work of the committee has merely opened the door to an entirely new field of valuable research for our government."

Sen. Aiken, Vt., said work done on the synthetic rubber program is not "wholly satisfactory as yet. The struggle is still going on with the petroleum interests seeking to control the manufacture of synthetic rubber. It may be they fear that alcohol will become of greater importance as a motor fuel if produced cheaply enough. Thanks to the work of the Senator from Iowa and his subcommittee . . . the alcohol process has been encouraged and developed in the U.S. . . ."

Sen. Willis said he did not wish to reflect upon those favoring production of rubber from petroleum "but I do wish to point out that after two years their program is not yet in full production. In fact, announcement was made recently that they expected the supply of synthetic rubber for 1944 to be delayed until the latter part of the year, owing to the unexpected obstacles encountered in making butadiene from petroleum."

WHERE THE FUEL GOES

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Col. Dewey Dims Hopes For Civilian Tires At Neches Dedication

Special to NPN

PORT NECHES, Tex. — Output of synthetic rubber in the U. S. by midsummer will reach a figure equal to the nation's yearly consumption of natural rubber during the prewar years, Rubber Administrator Bradley Dewey told a throng of 3500, mostly workers, at the dedication of the Neches Butane Co., largest plant of its kind in the world.

"While this is a historic accomplishment," he said, "let's not delude ourselves into believing the rubber problem is licked or that we civilians are certain to have tires in the near future to go joyriding around the countryside. Military demands must come first."

(*Report of an NPN staff man's tour of the Port Neches plant will be found in the March Technical Section starting on p.* R-121).

Praise for the five major oil companies, Gulf, Texas, Atlantic, Pure and Socony-Vacuum, for their efforts in making the big butadiene plant possible, also was expressed by Col. Dewey.

The rubber administrator was the principal speaker at the dedication of the huge plant. Other speakers were Bruce K. Brown, assistant deputy administrator of Petroleum Administration for War (*See NPN Feb.* 23, *p.* 3); Stanley T. Crossland, vice president of Rubber Reserve Corp., and Sidney Latham of Austin, Texas, secretary of state, who represented Gov. Coke Stevenson.

Mr. Crossland said the project was a challenge to demonstrate what the combined talents of ingenuity of the industry can produce in the way of chemical achievement to assist the war effort.

Establishment of a large segment of the synthetic rubber industry in Texas, he said, is merely a forerunner of a great chemical industry which will inevitably develop here due to the abundance of natural resources and excellent water transportation.

° ° °

U. S. Using More Natural Rubber Than Sources Can Supply

NPN News Bureau

WASHINGTON—The country is consuming natural rubber at considerably greater rate than it is being received from the few sources still available, the Combined Raw Materials Board warned Feb. 24.

"Even at the lowest rate to which we can compress natural rubber consumption, supply and requirements of natural rubber will not be in balance," the statement continued. "It is therefore essential that the greatest possible economy in the use of natural rubber continue to be maintained and that every step be taken to increase the amount of natural rubber available to the United Nations."

The statement pointed out that the considerable progress in production of American synthetic rubber has led to an under-estimation concerning the need for natural rubber.

"Synthetic rubber has not dispensed with the need for natural rubber," statement said. "Technical experts on both sides of the Atlantic have made large strides in learning how to use synthetic rubber in place of crude. It is essential that we continue our efforts to increase the proportions of synthetic rubber in tires and all other products in which some natural rubber is still being employed."

Louisiana Refineries Given OCD Security Awards

NPN News Bureau

WASHINGTON — Included in a list of 28 plants to which the Office of Civilian Defense has announced grants of the National Security Award for superior achievement in plant security organization are two oil company facilities, Standard Oil Co. of Louisiana, Baton Rouge, La., and Shell Oil Co., Norco, La.

The award was established by OCD to give public recognition to plants and facilities that have achieved outstanding program of protection of plant structures, personnel, and production processes against air raids, fires, sabotage, explosion and similar hazards.

To qualify for the award, the plants must not only establish an outstanding security and protection organization within the plant, but must integrate their plant organization with the civilian defense protection units of the whole community. The awards will be made at ceremonies to be held soon.

Recent Patents

REFINING

Recovery of valuable hydrocarbons. Newcomb K. Chaney, Moylan, Pa., assignor to United Gas Improvement Co. Filed Dec. 5, 1939. No. 2,341,527.

Process for removing fluorine from hydrocarbon distillates. Francis C. Moriarty, Chicago, Ill., assignor to Universal Oil Products Co. Filed Jan. 25, 1943. No. 2,341,567.

Treatment of hydrocarbon oils. Vladimir P. Ipatieff and Louis Schmerling, Chicago, Ill., assignors to Universal Oil Products Co. Filed Sept. 13, 1940. No. 2,341,782.

Catalytic treatment of hydrocarbons. Elmer R. Kanhofer, Chicago, Ill., assignor to Universal Oil Products Co. Filed Apr. 14, 1941. No. 2,341,792.

Extractive distillation. Gino Pierotti and Clarence L. Dunn, Berkeley, Calif., assignors to Shell Development Co. Filed July 21, 1941. No. 2,341,812.

Alkylation process. Arthur R. Goldsby, Beacon, N. Y., assignor to Texas Co. Filed June 7, 1939. No. 2,341,863.

Manufacture of turbine oils. Lawrence L. Lovell, Wood River, Ill., assignor to Shell Development Co. Filed May 11, 1942. No. 2,341,874.

Process of removing acids from hydrocarbons. Alan C. Nixon, San Francisco, and David L. Yabroff, Berkeley, Calif., assignors to Shell Development Co. Filed May 17, 1941. No. 2,341,878.

Methods of removing mercaptans from hydrocarbon oils. Lawrence M. Henderson, Winnetka, and George W. Ayers, Jr., Chicago, Ill., assignors to Pure Oil Co. Filed Sept. 15, 1941.

Process for dehydrogenation of liquid and gaseous petroleum hydrocarbons. Herman B. Kipper, Accord, Mass. Filed Jan. 6, 1941. No. 2,341,995.

Halogenation of cyclopentane hydrocarbons. William A. Bailey, Jr., Berkeley, and Sumner H. McAllister, Lafayette, Calif., assignors to Shell Development Co. Filed March 4, 1940. No. 2,342,072.

Isomerizing hydrocarbons. Harry A. Cheney, Berkeley, Calif., assignor to Shell Development Co. Filed Jan. 6, 1942. No. 2,342,073.

Conversion of hydrocarbons. Vladimir A. Kalichevsky, Woodbury, N. J., assignor to Socony-Vacuum Oil Co. Filed June 12, 1942. No. 2,342,080.

Production of aromatic compounds. Alexander N. Sachanen and Rowland C. Hansford, Woodbury, N. J., assignors to Socony-Vacuum Oil Co. Filed Feb. 21, 1940. No. 2,342,090.

MISCELLANEOUS

Compounded oil. Arthur L. Lyman, Berkeley, and Lloyd H. Mulit, Richmond, Calif., assignors to Standard Oil Co. (Calif.) Filed Jan. 22, 1940. No. 2,341,565.

Motor fuel composition. William J. Backoff and Norman D. Williams, Chicago, John F. O'Loughlin, Winnetka, Harry L. Moore, Niles Center, and John S. Yule, Chicago, Ill., assignors to Pure Oil Co. Filed Oct. 9, 1940. No. 2,341,892.

Inhibited oil. Stanley F. Waugh, Westfield, N. J., assignor to Tide Water Associated Oil Co. Filed Apr. 18, 1941. No. 2,342,027.

Production of organic acids. Carl N. Zellner, Elizabeth, N. J., assignor to Tide Water Associated Oil Co. Filed Mar. 28, 1941. No. 2,342,028.

Compiled by R. E. Burnham, patent and trade-mark attorney, 511 11th Street, NW, Washington 4, D. C., from whom copies may be obtained at rate of 25c each. State number of patent and name of inventor when ordering.

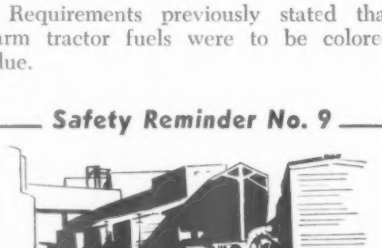
Minnesota Orders Green Dye For Farm Tractor Fuels

Special to NPN

ST. PAUL, MINN.—Superseding Regulation No. 7 issued July 15, 1943, the Minnesota state Department of Taxation has issued a new Regulation 7, effective Feb. 15, 1944, changing the color of all farm tractor fuels. Regulation reads: "All farm tractor fuels shall be dyed at the point of origin with a harmless green dye of sufficient quantity to color the finished product a green not lighter than the color standard supplied by the Commissioner of Taxation. No other petroleum products shall be colored green.

Requirements previously stated that farm tractor fuels were to be colored blue.

Safety Reminder No. 9



Prepared for NPN by National Safety Council

Stop signs protect workmen unloading drums from box cars, preventing jolts and damage to drums as well as eliminating the possibility of injury to workmen.

WHAT'S CHICKEN FEED TO AN OIL MAN?

CAN YOU IMAGINE getting excited about a single barrel per day yield? Or . . . of all things . . . a ¼-barrel?

Yet just such chicken feed capacities have determined the destiny of oil . . . worth *billions.*

For these outputs are typical of the pilot plants that give M. W. Kellogg service a unique position in the refining business. Far beyond mere "glass labs," their columns tower 50 feet into the laboratory roof . . . reproducing, for practical application, 17 different types of refining processes.

These pilots take the rule-of-thumb out of our clients' projects. They pre-determine—*before a single item is purchased*—the optimum process design, the economic value of a proposed plant.

Here, for instance, is a measure of the accuracy of the chemical engineering data revealed by the fluid catalytic-cracking pilot unit. From the information thus obtained, Kellogg is simultaneously building—without further ado—"cat" plants whose combined output represents over 50% of the United Nations capacity contracted for since the start of the war.

But pilot plants are only one link. M. W. Kellogg service is an endless chain. We evolve the required engineering data. We apply it. We develop process methods. We design. We erect the plant. We supervise initial operation. All on one basis . . . total war production *now* . . . with a head start on postwar competition for our clients.

THE M. W. KELLOGG COMPANY

★ Only Kellogg Service Has Them All

★ **LABORATORIES**—fully equipped and staffed—devoted exclusively to chemical engineering and process development.

★ **24-HOUR-A-DAY PILOT PLANTS**—17 refining processes operating continuously—providing accurate data for commercial scale application.

★ **EXCLUSIVE CHEMICAL ENGINEERING DATA**—Continuously compiled . . . embracing both pilot plant runs and the operation of Kellogg-built refineries. Data extends from beginning of modern refining.

★ **PROCESS ENGINEERS**—Specialists who have continuously made major contributions to oil refining development, for more than 20 years . . . currently exemplified by their work on fluid catalytic-cracking.

★ **MECHANICAL ENGINEERS**—Kellogg installations—worth hundreds of millions—are their best reference.

★ **METALLURGICAL LABORATORY**—Establishes continuous check of specifications...creates new techniques for the fabrication of refining equipment.

★ **PERMANENT CONSTRUCTION CREWS**—Geared to function all over the world on single units or multiphase refineries . . . team-experience cuts costs, speeds construction.

★ **OPERATING STAFFS**—Specialists at placing new units "on stream" . . . training of refiner's own operating crews.

★ **LICENSING SERVICE**—Licenses available through Kellogg as Licensor or licensing agent for all types of refining processes.

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PAW Announces Near Completion Of 2 New Pipeline Outlets

NPN News Bureau

WASHINGTON — Completion within the next six weeks of the two new pipeline outlets for West Texas crude is expected by PAW.

Pipe laying on Stanolind's 385-mile 16-in. line from Slaughter Field to Drumright, Okla., is 70% completed, while construction of Magnolia's 335-mile 12-in. line from Midland to Corsicana, Texas, is 93% complete. Lines will have capacities of 65,000 and 42,000 b/d respectively.

Through Feb. 18, five construction gangs on the Stanolind project had strung 312 miles of pipe, dug 275 miles of ditch, welded 270 miles of pipe and completed 179 miles of back-fill. Pease, South Fork of Red, Wichita, and South Canadian river crossings are completed, and crossing of the North Fork of Red River is 40% done. By end of February sufficient equipment should be installed in Slaughter station to run 40,000 b/d of crude to Drumright when pipe laying is completed. First 40 miles of the line north of Slaughter will be filled as soon as the initial station is ready to operate. Expected completion date on the project is end of March.

On the Magnolia project, 46 miles of 8-in. loops between Midland and Seminole are completed and in service, while 311 miles of main 12-in. line is now in the ground and entire project should be in operation sometime during March.

'Locally Needed' Rating Asked For Illinois Distributors

NPN News Bureau

WASHINGTON — PAW has written WMC area directors that it believes distributors in eight Illinois counties and one Indiana county should be declared "locally needed" following manpower surveys made in the area.

The eight Illinois counties affected are Grundy, LaSalle, DeKalb, Clay, Monroe, Kankakee, Stephenson and Coles; Indiana county is Marion.

Of 72 men employed by distributors in above counties in supervisory jobs, 25 are draft eligible and the "locally needed" declaration will aid PAW in requesting deferment of key men. Out of 348 drivers employed by distributors, about 142 are eligible for the draft.

ICC Urges Better Lubrication in Analysis Of 1942 Accidents to Carrier Vehicles

NPN News Bureau

WASHINGTON—In an analysis of mechanical defect accidents of passenger and property carrying vehicles in 1942, the Interstate Commerce Commission this week emphasized that the shortage of repair parts has made it doubly important that vehicles be properly and periodically lubricated.

A number of serious accidents called to ICC's attention, the report said, were due to lack of lubrication. One was due to insufficient lubrication on a wheel bearing which so affected steering that three people were killed and 17 others injured. Property damage to the carrier's vehicle was about $6000.

"This accident," ICC's report stated, "clearly showed the serious consequences chargeable to the lack of a relatively small amount of grease."

Of an estimated 8998 accidents reported in 1942, 619, or 6.9%, were classed as "mechanical defect" accidents. The total number of accidents reported to the commission in 1942 was only 61 per cent of the accidents reported in 1941. This is partly due to a change in ICC's rules regarding the reporting of accidents. Prior to May 1, 1942, accidents involving property damage were required to be reported only if they amounted to $25 or more. Subsequently the figure was raised to $100.

Causes Analyzed

The following table analyzes mechanical-defect accidents by type of defect:

Number of Accidents	Per Cent	Type of Accident
188	30.1	Brakes
78	12.5	Tires
73	11.7	Engines
57	9.1	Steering
37	5.9	Coupling devices
35	5.6	Wheels and associated parts
33	5.3	Lights
26	4.2	Springs, bolts, shackles, U-bolts
19	3.1	Axles and differentials
14	2.2	Fuel lines
12	1.9	Exhaust pipes, gaskets, mufflers
9	1.4	Clutches
7	1.1	Throttles and accelerator pedals
6	1.0	Batteries and battery cables
5	0.8	Windshield wipers
4	0.6	Transmissions
4	0.6	Unspecified mechanical defect
3	0.5	Driveshafts and universal joints
2	0.3	Frames
13	2.1	Others
625	100.00	

Most mechanical defect accidents occurred in March, with those due to brakes, tires and engines the most frequent. December and August rated second and third in frequency of accidents. When time of day was considered, the most frequent hour was 5 o'clock in the morning. No other hour appears to be outstanding.

From data on brake accidents, the commission listed these conclusions: (1) property damage per accident for 1942 brake accidents ($1,435) is about 2.4 times the amount it was for 1941 ($611); (2) fatalities per brake accident for 1942 (0.133) are more than three times what they were in 1941 while injuries per accident in 1942 (0.83) are somewhat more than a quarter greater than for 1941 (0.66); (3) most of 1942 brake accidents were of collision type (67.6%) and collisions involving private passenger cars were more numerous than all other kinds constituting 38.6% of all brake accidents; (4) as the Bureau of Motor Carriers has found in previous studies, most of the brake defects on vehicles or combinations are of a relatively minor nature; (5) apparently there are a number of combinations equipped with parking brakes of insufficient capacity to hold the combinations on grades; (6) the known dollar value of property damage ($269,838) resulting from all brake accidents is about $633 more per accident than the average property damage in the generality of accidents, and the greatest amount of this damage is suffered by the carriers' vehicles and cargoes.

Tire Accidents Costly

Of the 1942 accidents in which the sample was large enough to warrant any definite conclusions, tire failures are the highest in property damage as well as personal casualties per accident. In severity, tire failures ranked high in 1941 and highest for the sum of 1941 and 1942 mechanical defect accidents. Brake accidents in 1942 were the most severe in both personal casualties and property damage.

Personal casualties per mechanical defect accident by particular types and for the generality of accidents reported to ICC for 1941 and 1942 were not

Ships Honor Oil Notables

NPN News Bureau

WASHINGTON — Of six noted Americans for whom the Maritime Commission this week announced Liberty Ships had been named, two are widely known to the oil industry.

Ida M. Tarbell, eminent writer and biographer, is one and the second is Robert L. Hague, who for many years was manager of New Jersey Standard's marine department.

Miss Tarbell, who died only a few weeks ago, joined the staff of McClure's Magazine in 1894 and a few years later sky-rocketed to fame with her book "History of the Standard Oil Company". Mr. Hague, who died in 1939, began his sea career as a boy with the fishing schooners off the Grand Banks of Newfoundland. In 1920 he became manager of the New Jersey Standard's marine department and vice president and a director in 1937.

GIGANTIC *market for farm lubricating greases awaits you—*

1. 1944 will witness the most gigantic planting program in our nation's history—380,000,000 acres in cultivation; 16,000,000 ***more*** than in '43;

2. On the nation's farms are 1,100,000 trucks; 4,250,000 automobiles; 1,600,000 tractors; 1,500,000 trailers, and 3,000,000 wagons that ***must*** be kept in condition to handle these crops;

3. The aggregate farm income is up 20%—up to $20,000,000,000 annually—which means there is plenty of money for

BAT'S 1144 Lubricant

manufactured specially to aid America's Farmers

KEEP THEIR WAR EQUIPMENT FIT AND FIGHTING
FOOD FIGHTS for freedom

BATTENFELD
GREASE & OIL CORPORATION
"Business is Ingreasing"
KANSAS CITY, MO. MINNEAPOLIS, MINN.

much different. Property damage per accident increased 77% from 1941 ($451) to 1942 ($802). Property damage per accident for mechanical defect accidents increased 82% from 1941 ($656) to 1942 ($1195). The property damage per accident for mechanical defect accidents was 49% more than for the generality of accidents in 1942 while this increase over 1941 was 45 per cent.

Property damage per accident was found by ICC to be much higher in 1942 than in 1941, but this same condition, the report stated, is true for the generality of accidents and is probably due to the fact that carriers are hauling heavier loads and more valuable cargoes.

In its list of recommendations, ICC said the data presented on 1942 accidents plainly indicate the need for better inspection and maintenance practices, particularly with regard to mechanical or electrical parts involved in accidents.

Because of the present serious rubber situation, the commission said, every precaution should be taken to assure not only that tires be in safe condition but every possible means be used to preserve them. Attention should be paid to inflation pressures of tires en route, it was pointed out, to assure that vehicles are not running on underinflated or flat tires.

It was also emphasized that a very large part of the total losses of individual vehicles results from accidents involving fires for which the original cause is a mechanical defect. Whatever correction is made in inspection and maintenance practices to lower the number of accidents traceable to mechanical defects would have the effect of decreasing the number of fires and consequently the number of total losses which result from fires.

98% of 1943 Farm Crop Moved By Motor Truck, Says ODT

NPN News Bureau

WASHINGTON—Motor trucks moved 98% of the 1943 farm crop at some stage of its journey from farm to market, ODT reported Feb. 16. It was pointed out that the big job of hauling was accomplished despite the fact that there were fewer vehicles available for farm transportation in 1943 than in the preceding year.

A total of 1,600,000 trucks, the bulk of which were farmer-owned, ODT said, moved farm products to markets or rail-junctions and farm supplies from urban to rural areas. The rest were "for hire" trucks engaged wholly or primarily in hauling farm products.

Farmer co-operation and co-operation of truck operators with ODT's conservation program, the agency said, was responsible for the ability of trucks to transport the 1943 farm crop. The direct result of the program has been not a curtailment of necessary transportation but the elimination of wasteful and unnecessary operation, according to ODT.

1,500,000 Cars Junked in '43, Toll Rising, ODT Reports

Special to NPN

SPRINGFIELD, Ill.—ODT estimates that 1,500,000 motor vehicles were junked last year, according to a bulletin issued by the Illinois Division of Highways. Comparative figures show this to be twice the number junked in 1942 while estimates for 1944 add another 2,000,000 to the number.

The average age of war production plant employes' cars is given as seven years by the Public Roads Administration although in half of the areas surveyed, 20-30% of cars serving war plants were found to be 10 years old and over. In the light of the current shortage of repair parts, the situation can only become more serious in the future, the bulletin stated.

Bayou 'Salvage Miracle' Pipeline Tops Records

Special to NPN

HOUSTON, Tex. — The Bayou pipeline system, 300 miles of products line from Houston and Texas City, Tex., to Baton Rouge, La., on Feb. 15 completed a year of war service, H. H. Anderson, vice-president of Shell Pipe Line Corp., announces. The Bayou line, known as "a miracle of salvage construction", was projected in 1942 to feed the Plantation pipeline from Baton Rouge to Richmond, Va., direct from Gulf Coast refineries.

Subsidiaries of six major oil companies financed the $8,000,000 emergency project and Shell Pipe Line Corp. was named to design and construct the Bayou system and operate it for the duration.

Every mile of pipe that went into the construction came from obsolescent or from crude oil line pipe, less needed at the time. Pumps and motors, with many of the fittings, were taken from other uses or from retired stock. Construction plans were adapted to available reconditioned equipment.

The Bayou line runs through low, swampy land along the Gulf Coast with a maximum elevation of 61 feet. All the pipe had to be coated against rust. The line went into operation in February, 1943, and first oil reached Baton Rouge on Feb. 15.

The line carries premium and house brand gasoline and kerosine of Humble, Texas, Shell, Pan-American, Pure and Crown-Central. The line was designed to deliver 57,000 b/d but it has operated at 66,440 b/d and averages 63,500 b/d.

Bus Line to Close 395-Mi. Gap On Inter-American Highway

NPN News Bureau

WASHINGTON — The Central American press reports that a bus line is scheduled to operate between San Salvador, the capital of El Salvador, and Managua, the capital of Nicaragua. This is the only part of the Inter-American Highway route between Tapachula, Mexico, and Rivas, in Southern Nicaragua, not now served by busses.

Busses run between Tapachula and San Salvador, a distance of 372 miles, and between Managua and Rivas, a distance of 70 miles. The missing link between San Salvador and Managua is 395 miles long.

Edwin W. James, chief of the Inter-American Regional Office of the U. S. Public Roads Administration, describes as "practicable" operation of a bus service between the two capitals, as far as road conditions between San Salvador and Managua are concerned.

Mr. James recently inspected the co-operative highway work the U. S. Public Roads Administration is doing in conjunction with the Central American republics to complete this vital highway.

Eastward Rail Hauls Drop To 685,471 b/d

NPN News Bureau

WASHINGTON—Rail hauls of crude and products to the East Coast averaged 685,471 b/d during the week ended Feb. 19 compared with 727,904 b/d the previous week, PAW reported Feb. 23. A total of 62 participating oil companies loaded 22,256 tank cars as follows:

Abercrombie-Harrison	109	Globe	76	Shotmeyer	9
Allied	43	Gulf	2,225	Sinclair	1,033
American Bitumuls	16	Hartol	221	Skelly	18
Amsco	319	Hess, Inc.	15	Socony-Vacuum	2,499
Arkansas Fuel Oil	9	Home Oil	16	Southland	19
Ashland Refining	88	Jenney Mnfg. Co.	39	S. O. California	16
Asiatic Petroleum	24	Libby	1	S. O. Indiana	295
Atlantic Refining	1,635	Maritime Oil	58	S. O. Kentucky	84
James B. Berry Sons	13	Pacific	62	S. O. New Jersey	3,906
Cantelou	11	Pan American	1,020	S. O. Ohio	265
Canton	9	Petroleum Corp.	121	Sterling	4
Chalmette	6	Petroleum Heat & Power	26	Sun	2,569
Cities Service	583	Phillips	215	Talco	7
Continental	345	Pioneer	1	Taylor Refining	182
Crown Petroleum	5	Primrose	61	Texaco	1,988
Daugherty	20	Pure	70	Tide Water	621
Deblois	8	Republic	148	Tiona	8
Deep Rock	36	Richfield	201	Triangle	34
Drake	3	Royal Petroleum	48	United	4
Elk Refining	36	Shell	723	Waggoner	10
Freedom Oil	15			Western Oil	5

Where Performance Really Counts

Count On

DEPENDABLE

Champion Spark Plugs

There are two kinds of spark plug performance—performance in engines and performance in sales.

Champion Spark Plugs have long been famous for better performance and dependability in every engine. Out of this grew a degree of acceptance by the motoring public which has been unsurpassed for years.

Today Champion Spark Plugs embody many patented and exclusive features, many technological developments and improvements that have raised the demands from our armed forces, and the home market to all time highs.

The moral is obvious to the dealer who is seeking the spark plug with the greatest performance potential from a sales, turnover and profit standpoint.

LET'S ALL BACK THE ATTACK—BUY WAR BONDS

Boats Held Early Fascination For David Day

Who is David I. Day whose byline precedes river yarns and facts on the oily angle of inland waterways?

Dave himself advises us that a former neighbor was sadly wrong when she voiced her opinion of him on the occasion of his marriage to high school teacher Lucile Ayer some 30 years ago. Said this neighbor:

Mr. Day

"Lucile has driven her ducks to a poor market." For since that time Mr. and Mrs. Day have reared five children, the oldest, David I. Jr., having been elected state's attorney at the age of 21, now assistant public counselor of the state of Indiana. The other children have equally promising careers, including a son in the army.

Mr. Day was born in Spencer County, Indiana near where Abe Lincoln grew up, 78 years after the great emancipator's birth. But he missed by a foot attaining Honest Abe's height. There were other slight analogies. They both went to one-room schools; they both had a pretty tough childhood; they both became teachers.

But as a youngster, Lincoln became interested in law and politics, while Day's interest ran to old steamers on the Ohio, like the *Morning Star, Tell City, Tarascon* and others. He grew up reading river books, and as a kid had dreams of adventure as portrayed by Mark Twain. A chance article on the life of an early U. S. Senator named Hannegan drew him into a newspaper office, where he landed a job as a reporter and feature writer. He's been doing it ever since, except occasionally when he switched to other endeavors, such as teaching school, "just for the hell of it" he says, and publicity work.

Always the "old river stuff" brought him back to writing. Several years ago he discovered that he could make more money free lancing, and he has been doing it very successfully ever since. His writings have appeared in most of the marine journals, and he is staff correspondent for a number of marine publications, and is writing regularly for 23 publications.

Barge Notes—

Sohio's Towboat Ellen Getting Larger Engines in Overhaul Job at Paducah

By David I. Day

THE *Ellen* operating as a steam towboat for the Standard Oil of Ohio is being converted at Paducah, Ky., into a 1230 h.p. Diesel towboat, using twin Cooper-Bessemer engines. This boat is 156 feet long, 30 feet wide, and 5 feet, 2 inches in hull depth, formerly the property of the U. S. Engineers at Rock Island, Ill. When the conversion is completed, she will move up the river from Mt. Vernon, Ind., with much larger tows of oil.

The *Minneapolis Husky* is now operating under the name of *Republic-Pittsburgh*, a fact creating much interest as she came up the Mississippi recently. She is due for re-designing also to increase her power and load capacity. The tanker is owned by the Husky Transit Co., Houston, a subsidiary of the Republic Oil & Refining Co., Pittsburgh.

Ice melted in the Mississippi and clear water ran above Davenport, only to freeze over again. However, all indications are that March tows may go up to the Twin Cities. The Federal Barge Lines are all set to institute service. Much speculation existed above St. Louis as to what boat would make it up to Minneapolis with the first spring oil. Last spring the *Chas. W. Snider*, sensational towboat of the Pure Oil fleet had the honor and with Capt. Vinson her commander rated reams of up-river newspaper publicity.

On the lower Ohio last week and early this week, there was considerable movement of petroleum products. The Sohio fleet was most in evidence with two big tows in charge of the *Edgar C. Johnston* and the *Sohio*.

At Evansville I received a wire from a friend at Helena, Ark., telling of a fire there in an oil barge while the *Harry Z*, of the Zubik Towing Co., Pittsburgh, was making up an oil tow. The oil in one compartment was lost but no one was seriously burned. A DPC barge was damaged also at that time. This reminds me of the good work of the numerous DPC towboats on all our important rivers.

Went by train to Cincinnati. The steamer *Bob Tresler* of the Tresler Oil Co. there is being repaired downriver at Madison, Ind. This steamer has been doing good work. Many river folk recall her when she was the *Volcano* on the Monongahela River years ago, later called the *Mengel* pushing tows on the Mississippi.

On the upper Ohio observed the fine steamer *Charles T. Campbell* with several barges of gasoline in tow. The old *D. W. Wisherd* was also at work in the same waters. The *Reliance* of the Union Barge Lines, the *St. Louis Socony*, the *St. Paul Socony*, the *Vagabond*, the steamer *Jos. Chotin*, the *Henry C. Ogram*, and the *Paul Blazer* were all active. The following day I noted the *Dan Quinn* of the Patton-Tully fleet of Memphis. Observed on the journey some 50 barges of up-bound petroleum products.

Much comment was heard at Huntington of the performance all winter of sister steamers, the *Charles T. Campbell* and the *John W. Hubbard*. Both have had improvements made in their engine rooms, both are equipped with monkey rudders, and have been moving long tows around the sharp river bends with an agility that seems almost impossible. The Union Barge Line has chartered one of the new 19 DPC steam towboats, the *Tulagi*, and many expected to see the new 2000 h.p. boat coming up with oil to Pittsburgh one of these days. The big steamers so far have done fine work. Some revisions in steering facilities have been required but the power they exhibit reminds one of the prowess of the *Sprague*, biggest and one of the oldest of steam towboats, built in 1902. She is the property of the Standard Oil of Louisiana and none of the new ones can beat the old giant on a straight push.

Received at Huntington a letter on the work between Baton Rouge, La., and New Madrid, Mo., of the Diesel boat *Harry Simpson, Jr.*, of the Simpson Oil Co., Charleston, Mo. I have written feature stories on nearly all the recent vintage of towboats and no task gave greater pleasure than a story on this boat some months ago. She is 103 feet long, using an 810 h.p. engine, built last year at the Nashville Bridge yards.

The letter stated the boat was bringing up big tows in record time, some round trips being three and four days less than customary. She is a sister vessel to the *Gladys Simpson*, also a dependable pusher, and due for some changes and improvements soon. The same letter brought some news from my old favorite port of Greenville, Miss., where the Republic Oil boats, the *White Water* and *James E. Graham* were observed with tows and the DPC steamer *Wake Island* was noted below coming up with oil.

On my return trip I saw the *Irvin S. Cobb* of the Igert fleet of Paducah near Louisville with the tow of four barges of oil. This boat never fails to attract attention being the most powerful of the Diesel sternwheelers, using National Superior engines developing 615 h.p. A companion boat, the *Louis Igert Jr.*, has been noted several times in mid-Ohio waters pushing petroleum products. This boat is about 100 feet long and is powered with Fairbanks-Morse engines of 450 h.p.

The World's Finest General Purpose Grease Gun

EXCLUSIVE NEW ★ POWER NOSE

Full, free feed of light or heavy greases; warm or cold weather. No narrow slot. 360°, frictionless feed to pressure cylinder.

Engineered for Strength Simplicity and Easy Action

★ LUBE-ALL

EXCLUSIVE ★ STREAMLINED GREASE GUN

KEEPS EQUIPMENT MOVING DOWN ON THE FARM . . .

SPECIFICATIONS
Model 166H. 30 lb. capacity. Complete with 6 ft. length of 3/8" volume delivery hose, swivel and 8" hydraulic coupler.

★ BALCRANK FARM-TRACTOR LUBRICATOR . . .

Every farm should have this low-priced lubricator. Adequately and easily lubricates any equipment that requires grease to be forced thru a fitting such as tractors, trucks, threshing machines, binders, etc. Convenient to carry to and from jobs. Easy hand-operated, high pressure, volume delivery. Handles either viscous or fluid lubricant.

HERE'S THE GUN that puts EASE in grEASE jobs! . . . the gun that has EVERYTHING you can get in all other guns, ***PLUS*** exclusive features only Balcrank offers.

Features that make for Easier, Quicker, Cleaner Operation; Positive Action; Lifetime, Dependable Service:

Exclusive streamlined design. Power-grip, Fist-fit handle. Safety clearance to prevent pinched fingers, barked knuckles. Scientific angle of tube and coupler for easier, increased power. Short-arc handle thrust for greater ease in cramped, hard-to-get-at places. Knurled barrel for easy gripping. Simplified, fewer parts. Heavy-duty barrel, spring, double leathers, follow plate. Precision lapped piston and piston wall. . . . Plus a dozen other new mechanical improvements and engineering refinements.

Finished in fire-engine-red, baked enamel; each gun packed in individual carton.

BALCRANK Inc.

CINCINNATI 9, OHIO

★ MANUFACTURERS OF A COMPLETE LINE OF LUBRICATING EQUIPMENT

★ ORDER FROM YOUR WHOLESALER—TODAY!

W. Coast Supply Topic For A.P.I. Group In Los Angeles March 23

NPN News Bureau

LOS ANGELES—Spring meeting of the Pacific Coast district of the American Petroleum Institute's Division of Production will be held here March 23 to consider the Pacific Coast petroleum supply situation, oil on the public domain and problems of drilling and production technology in wartime.

W. L. Jarvis, The Texas Co., is chairman of the program committee. Day sessions will be held in the Biltmore Hotel, and an evening session in the Biltmore Bowl.

J. R. Pemberton, California state oil umpire, will discuss the critical supply situation in California due to the enormous demands for petroleum in the Pacific war theatre. Robert E. Allen, director of the Institute's department of information, will speak on "People and Petroleum," and R. M. Allan, Jr., of Superior Oil Co., will discuss "Should Oil Developments on the Public Domain be Encouraged?" A new sound color motion picture, "Victory's Oil," will be shown.

Tentative Program

Following is the tentative program: Morning: "Analysis and Use of P-V-T Data in Material-Balance Calculations," by Robert F. Loeck, Standard Oil Co. of California, San Francisco; "Development and Production Performance of the Porter Reservoir, Aliso Canyon Field," by G. C. Pfeffer and A. C. Tutschulte, Tide Water Associated Oil Co., Santa Fe Springs; "Determination of the Interstitial-Water Content of Oil and Gas Sand by Laboratory Tests of Core Samples," by J. J. McCullough and P. H. Jones, Union Oil Co. Research Dept., Wilmington; "Should Oil Developments on the Public Domain be Encouraged?" by Mr. Allan; and "Drilling Fluid for the Completion of Shallow Wells," by W. H. Farrand and W. A. Clark, The Texas Co., Los Angeles.

Afternoon: "Controlled Water-Flood Development and Operations in the Mid Continent," by R. C. Earlougher, Geologic Standards Co., Tulsa; "Load Problems of a Natural-Gas Utility," by H. P. George, Southern California Gas Co., Los Angeles; and "People and Petroleum," by Mr. Allen followed by motion picture, "Victory's Oil."

Evening: "What Shall We Do About the Present Oil Situation in California?" by Mr. Pemberton.

Tulsa Seeks Geologist Parley

TULSA — The Tulsa Geological Society has ordered President R. E. Garrett formally to draft an invitation to the American Assn. of Petroleum Geologists to meet in Tulsa in 1945. Last meeting here was in 1935, and since that time A.A.P.G. has met at Denver, Oklahoma City, San Antonio, Houston, New Orleans and Fort Worth, with the 1944 meeting scheduled for Dallas, March 21-23.

Humble Output Increases More Than 50% in '43

Special to NPN

HOUSTON — The Humble Co. stepped up its production by more than 50% as compared with 1942, H. C. Wiess, president, told stockholders at their annual meeting.

Humble's gross crude production last year was 106,000,000 bbls. or 291,000 b/d. After deducting royalties and interests of others, the net production was 86,000,000 bbls. or 236,500 b/d.

The increase shown by Humble last year compared with an increase of 21% by the oil industry in Texas, New Mexico and the Louisiana Gulf coast.

Mr. Wiess said that the gain in Humble's production at a more rapid rate than the territory was made possible by the careful accumulation and development of large reserves over the past 25 years and was not due to more wells. He said that the 8000 wells operated by Humble and the 745 wells in which the company had an interest at the end of 1943 were only 70 and 45, respectively, higher than the year before.

California Standard Prepares To Stake 15,000 Ft. Well

NPN News Bureau

LOS ANGELES — Standard of California announced Feb. 23 that it is about ready to stake what may be the deepest well in the world.

The well is located in the vast Midway Sunset Field of California and is expected to go down 15,000 ft.

Gulf Coast Runs Show Increase

HOUSTON — Crude runs of the Gulf Coast Refiners Assn. increased to 113,557 b/d in the first half of February, an increase of 33,000 b/d over the same period last year.

Gasoline stocks in the first half of the month increased 187,941 bbls. to 1,658,492 bbls. while kerosine stocks of 200,000 bbls. show little change.

Diesel gas oil stocks totaled 60,214 bbls. on Feb. 1, a decline from last year, while gas oil, used as light fuel oils and cracking plant charging stocks totaled 942,118 bbls., a decline from the Feb. 1 stocks of 999,948 bbls. Heavier fuel oils increased 155,014 bbls. to 1,002,032.

Complicated Gas Tax Due for Airing In Texas Supreme Court

Special to NPN

AUSTIN — The Texas Supreme Court has agreed to review a tax case which may result in an interpretation of the complex Texas tax law on natural gas production which is used for the extraction of distillates.

The estate of W. R. Davis appealed from a judgment of a district court which awarded the state $6809 for occupation taxes on gas production, and upheld a statute which declares the tax value of gas from which products are extracted, separated or saved shall be three-fifths of the gross value of the product. The district court was upheld by the Galveston Court of Civil Appeals.

The different prices paid for gas in Texas—ranging from less than one cent per thousand cubic feet to five cents—has made evaluation of the product a subject of long controversy.

State Tax Receipts Up

Meanwhile the state's take on natural gas taxes showed a considerable increase in 1944 over 1943, due to both the increased production of gas and a higher price, according to figures released by George Sheppard, state comptroller.

In 1943 the tax brought in $2,701,605, an increase of $322,789 over the previous year.

Mr. Sheppard's figures showed that one significant factor contributing to the increase was $653,706 collected from recycling operations. There are more than 35 such plants in Texas, with much of their output in petroleum liquids going into the war effort.

It was impossible to deduct from the tax figures the amount of gas produced in Texas during the year, due to different values on gas and also to the fact that gas burned legally at the well or used to repressure a field bears no tax.

Kansas March Allowable Set

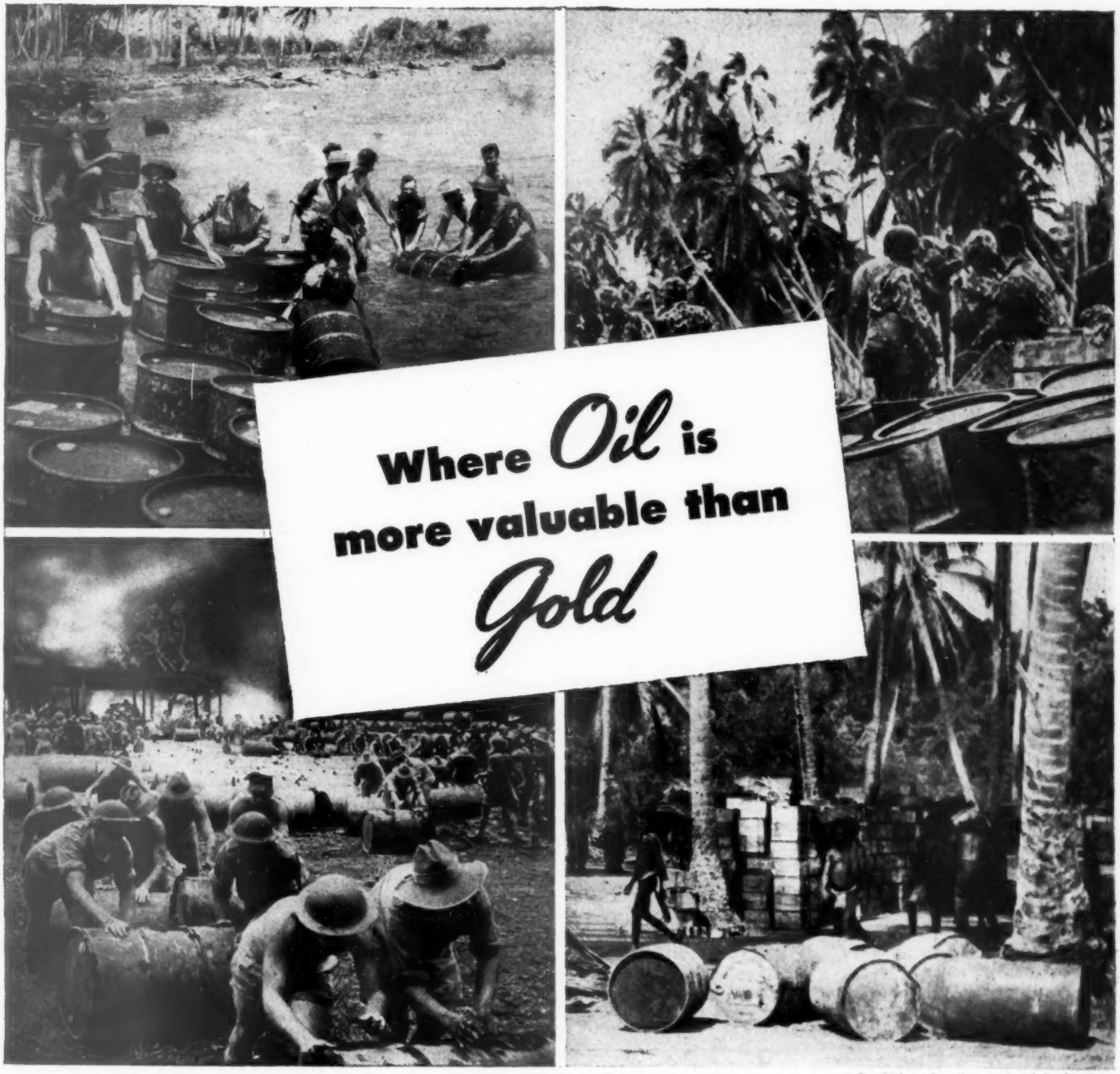
Special to NPN

WICHITA — Kansas State Corporation Commission has set March crude allowable at 275,000 b/d, unchanged from February. Allowable includes 5600 b/d for petroleum liquids other than crude, same figures as for February. The PAW recommendation was 291,000 b/d and crude oil purchasing companies nominated 349,135 b/d. Average actual production for three weeks ending Feb. 21 was 276,502 b/d.

Probe Claim of Gas Waste

Special to NPN

AUSTIN—A public hearing has been set here for March 3 by the Texas Railroad Commission on alleged gas waste in Agua Dulce Field, Nueces County.



Official Photos from International, Pathe, Acme

DO you want to see oil that is worth many times its weight in gold — oil on which the lives of men, and the fate of whole continents, may depend? Look at these photographs from the South Pacific.

Do you want to see how this precious fuel — this "liquid ammunition" — is *protected?* Look at the drums. They are *hermetically sealed* with Tri-Sure Closures — sealed so tightly that *they can be rolled through the surf and exposed to torrential tropical storms* WITHOUT SEEPAGE.

"*Hermetically sealed*" — those two words will tell you why, all over the world, men who handle drums say, "*If it's in a Tri-Sure-equipped drum it's safe.*" And those two words — "hermetically sealed" — will tell you why Tri-Sure Closures will give *your product* the protection it should be getting from every hazard.

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TRI-SURE PRODUCTS LIMITED, ST. CATHARINES, ONTARIO, CANADA

OIL FINANCES SOUND

(*Continued from p. 20*)

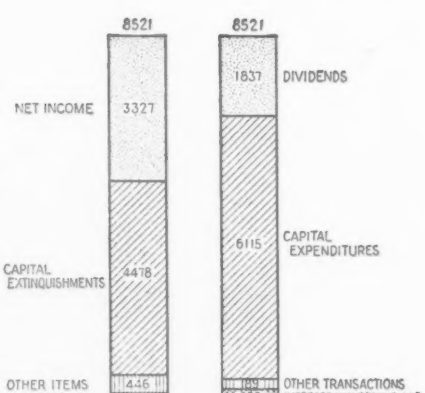
ing, 18.7%; all others, 2.2%.

11. The concentration of capital in large units is less than in many highly technological industries. The group in 1942 produced 54% and refined 79% of the totals for the country. Eighteen companies accounted for half of the nation's crude oil production; and 7 companies for half its refinery throughput.

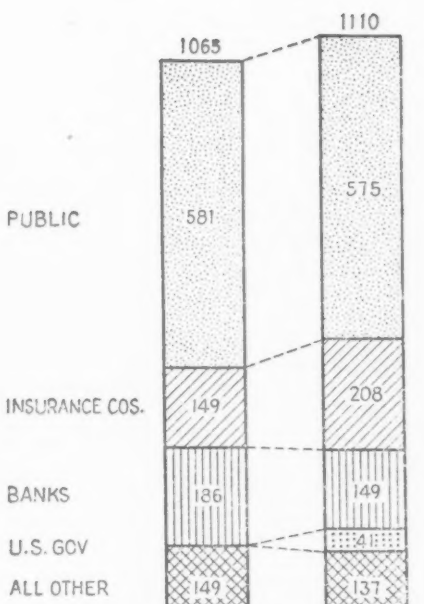
12. The combined results for the group indicate a declining trend since 1937 in the capital expenditures per barrel of crude oil produced. The data also permit the construction of an index of crude oil replacement cost which has a rising trend for the same period.

13. The group increased its crude oil production by 57% and its refining throughput by 43% between 1934 and 1942, as compared with an expansion of 25% in gross fixed assets, 19% in net fixed assets and 11% in borrowed and invested capital.

14. The combined statements indicate that the oil economy is functioning soundly and effectively.



Here are sources and disposition of funds for 30 oil companies for the nine-year period, 1934-42. Note the almost exact balance between the sum of net income and capital extinguishments, and the sum of dividends and capital expenditures, indicating that the industry generates its own capital. The increase in debt and stock is more than covered in the increase in net working capital



Here is a graphic analysis of the sources of funded and long-term debt for 30 oil companies on Dec. 31, 1941 and 1942. Note that the increase in debt during 1942 was provided largely by insurance companies, and that funds provided by banks declined to almost the exact degree that Government funds entered the business as a new factor

★ ★ ★

Net Assets of 30 Oil Companies at December 31, 1942
Segregated Between Domestic and Foreign

	Domestic	Foreign	Total
		Mill. Dolls.	
Net Working Capital	1,740	180	1,920
Investments & Advances	372	582	954
Properties, Plant, & Equipment (Net)	4,557	424	4,981
All Other	162	25	187
Sub-Total	6,831	1,211	8,042
Less: Long-Term Debt	1,064	46	1,110
Other Reserves	132	306	438
Minority Interest	136	135	271
Preferred Stock	173		173
Total Net Assets	5,326	724	6,050
Per Cent of Total	88.0%	12.0%	100.0%

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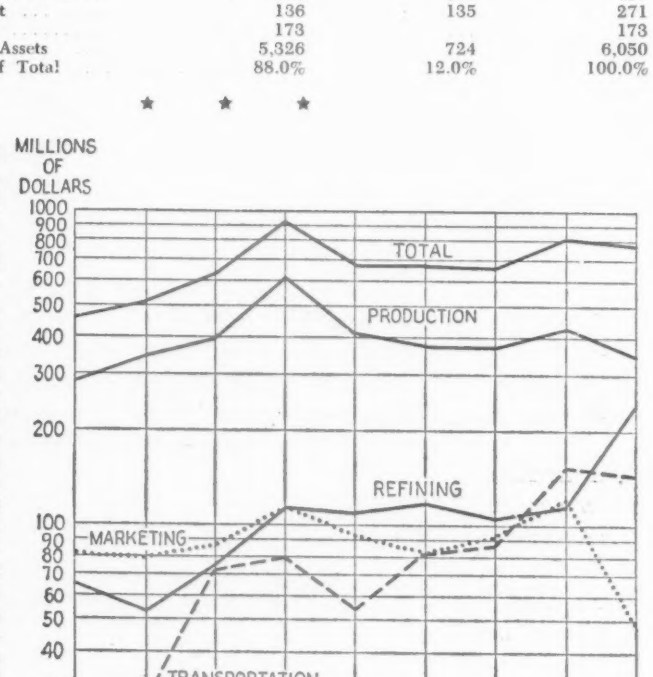
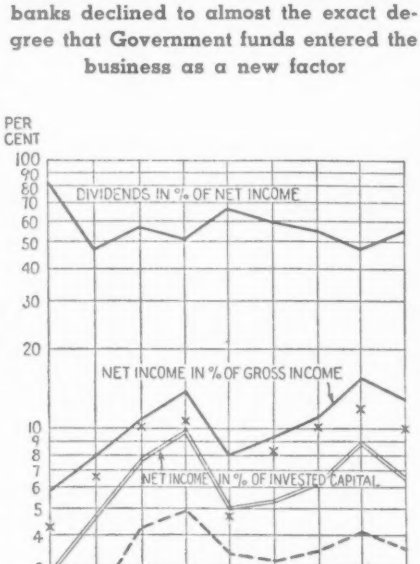


Showing trend of capital expenditures of 30 oil companies, subdivided into principal divisions of the business, by years, 1934-42. Semi-logarithmic scale. Note the large proportion of total going into production, and the downtrend in this division since 1937. Note also the impact of the first full year of our direct participation in the war (1942), particularly in respect to lessening of capital expenditures for production and marketing, and to increasing them sharply for refining. The uptrend in refining and transportation for the period is also noteworthy



The trend of indexes showing the productivity of capital employed by 30 oil companies, by years, 1934-42. Semi-logarithmic scale. The double line gives the rate of return on invested capital and this is sharply lower than the average for more than 1100 manufacturing concerns in all years but 1938. The topmost and bottommost curves show the low productivity of capital from the stockholders' point of view

Why the Reich is the wrong place to live . . .

one reason:

America's fighting four-engine, long-range bomber!

They've proved every claim made for them by their peacetime exponents, and more. They go fantastic distances to drop bombs of incredible size on the exact spot where they are least wanted—by the Axis. They have returned from missions so badly damaged that their condition was entered on the records as "absolutely unflyable." What's more, these bomb-boxcars are so armed that *one* of our heavies in the course of *one* mission shot down *twelve* enemy fighters!

another reason:

America's fighting petroleum industry!

The degree of participation required of the petroleum industry in the building, operation, and maintenance of a four-engine bomber, for example, is almost beyond grasp. A thousand different highly specialized lubricants are needed during manufacture and operation . . . instrument oils . . . hydraulic fluids . . . cutting oils . . . quenching oils . . . rustproof compounds . . . 100-octane fuels . . . engine lubricants.

The explosives our bombers drop; the gunpowder they shoot; the plastics, clear and opaque; the runway dressings —all these come from petroleum or its derivatives.

This is a fighting industry and Gulf's proud to be a part of it.

GULF

Iowa Independent Oil Jobbers' Assn. officers elected at the convention in Des Moines Feb. 23-24: Left to right, (seated) John W. Schultz, president; Gerhard; Goplerud, vice president; A. C. Gienapp, secretary; F. H. Hatch, treasurer; Earnest Peters, director; (standing) Gerald Phippen, V. W. Smith, E. F. Bock and Fred Thiel, directors.

IOWA JOBBERS GIVE OPA GENTLE JAB

(*Continued from p. 7*)

zone delivery plan was set up by ODT," he said. "If that plan had been allowed to go into effect, it would have ruined many of you jobbers as your association well knows. It gave no special support to the war effort. It was up to us to go to work and prove to these birds that it was unnecessary and would actually accomplish nothing."

He said the Iowa jobbers association had met and discussed the problem but could figure no solution except to condemn the original proposal. The subcommittee headed by H. T. Ashton of Socony-Vacuum was then appointed, made surveys in various areas and came up with information on the close utilization of equipment, manpower and internal efficiencies between companies under the joint use of marketing facilities, which replaced the unworkable ODT idea.

Another important committee development was the supply and distribution plan for products, he said.

"You jobbers in Dist. 2," Mr. Harms said, "have practically had no break or halt in your supply. Have any of you been without gasoline or other products for any indefinite length of time? No!" he declared, "you have had products practically uninterrupted for the past year."

If an allocation directive has to come in Dist. 2, he said, it would be the job of the committee to see that jobbers get a fair share of the available products. "If we don't," he said, "you may wake up and find you have nothing to sell and no place to buy supplies." Increased petroleum needs of farmers may become an important factor in allocations, he indicated but said he hoped the directive would never be issued.

Touching on transportation, he said that jobbers had been fortunate in getting truck and equipment repair parts, also tires. Truck transports are being manufactured and sold to petroleum transports, and he thought it may be possible to have some trucks released for the jobbers' needs.

The Dist. 2 marketing committee is being streamlined into the Distributors and Marketing Committee of 15 members, and it was his hope that more jobbers would be on the new committee to increase jobber prestige.

"With our minor representations of jobbers on the present committee," he said, "I have felt so useless at times that I mentioned to one of your directors that I thought I would resign, but like a fire engine without fire, I am convinced that I should remain and do all I can for you jobbers because from now on the going will get tougher fast . . . one of our prime objectives is a program of sustenance for the jobbers we represent. This is our theme song."

He then chided the jobbers because they had no increased margins in spite of extra costs for handling coupons and policing the rationing system for OPA —asserting the failure was theirs because they had not filled out the questionnaires last fall. "I want to remind you, your officials and your association that there is a lot of room for better support (of committees)," he said.

It costs about $500 a year in travelling expenses, which are paid personally, to maintain a marketing committee membership—and a lot of brain raking to keep jobbers in the picture, he said, urging the jobbers to be good soldiers and fill out whatever increased margin, manpower and other questionnaires were sent to them. The Dist. 2 industry office is supported by the industry at large, and he said in closing that he had been asked to mention that Dist. 2 committee was in need of funds for payrolls, etc. He asked that jobbers contribute financially.

Mr. Stegan of the OPA regional office at Chicago carried forward the new conception of OPA on rationing, as disclosed by Col. Bryan Houston at the Peoria, Ill., meeting the previous week. Col. Houston was on the Iowa program, but due to illness was unable to attend.

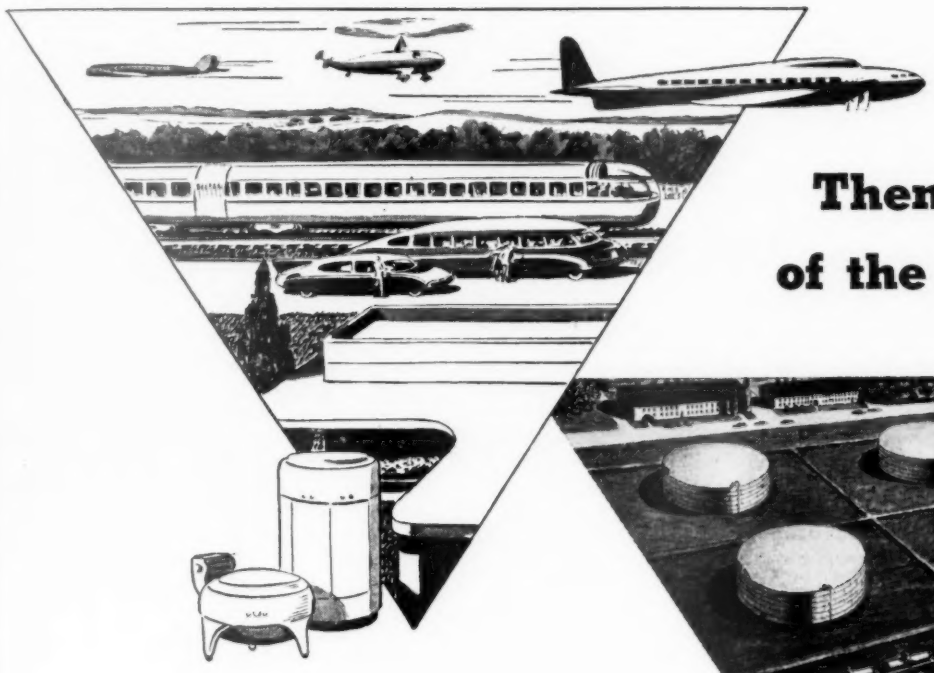
"Remember one thing," Mr. Stegan said in his opening. "OPA did not bomb Pearl Harbor! OPA has a program that we know is anti-American, but under war conditions it is a necessary one. In the automobile field for instance," he said, "we have only about 10,000 new cars left to ration and may have to take them away from the local boards and turn them over to district offices to dole out because the boards cannot ration one quarter of a car per month.

"However," he continued, "we will try to keep the present cars in mobile condition by manufacturing from 18,000,000 to 20,000,000 tires this year."

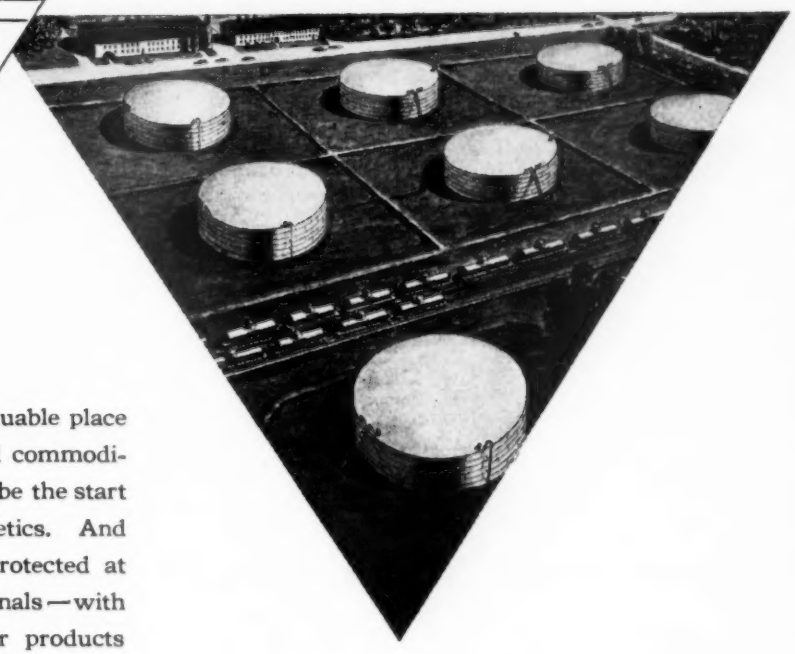
"As to gasoline," he said, "we are deeply concerned that OPA has not been able to bring issuance of gasoline currency within the limits of allocation of products by PAW."

He described the new OPA nonhighway gasoline rationing experiments in three Minnesota counties, in Georgia, Florida and Pennsylvania, and revealed that still another test was being made in West Virginia based upon tax refunds, "which really scares me," he said. He

If this is your picture of the future...



Then this is part of the picture too!



General American Terminals have a valuable place in your post-war planning. Your liquid commodities—animal, mineral, or vegetable—will be the start of planes and houses, clothes and cosmetics. And those liquid commodities will be protected at General American Tank Storage Terminals—with economy that will help make post-war products miracles of low price.

Make use of these exclusive General American advantages

1 RELIABLE CUSTODIANSHIP. *Our warehouse receipts are highest type of collateral everywhere.*

2 SPEED WITH SAFETY. *Day and night crews eliminate delays.*

3 INDEPENDENT OWNERSHIP. *Strict privacy. We do not buy, sell, or refine oils.*

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5 LARGE TANK CAR FLEET.

6 NO CONTAMINATION. *Separate pumps, lines, storage zones for dissimilar commodities.*

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A Division of General American Transportation Corporation

told of one farmer who was allocated 2004 gal. of gasoline, but who made no application for tax refund according to a check up that was made; another was allocated 2930 gal. and got tax refund on 350 gal.; another was allocated 4900 gal. and tax refund was asked for on only 440 gal.

Mr. Platt drew upon his 35 years of personal contact with oil jobbers and jobber associations to cite their improvement in appearance and financial stature "that is not to be sneezed at." He complimented Messrs. Bowles, Houston and Stegan for their new conception of OPA, which puts that government agency's operations more nearly on an Americanized basis.

"But one wonders what may be the "outcome of Mr. Ickes' invasion of the Middle East to obtain foreign oil," he continued. "Can it be that the government will bring crude oil here in government-owned tankers for refining on the East Coast, then put it in the eastern end of the Big and Little Inch Pipelines and supply it to co-operatives here in the Midwest? The government has an investment in co-ops", he said.

"Wise to Keep Looking"

"Whether or not that will be done is anybody's guess," he added, "but you can look under the bed the same as I can, and it does seem wise that you do some looking."

George C. Lloyd of the Iowa Petroleum Industries committee, also warned the jobbers: "Before another convention time rolls around, you will probably find that government has moved in and taken more of your time, because much history on the foreign and home fronts will have been made and written by then."

Mr. Groce, addressing the opening session, urged the jobbers toward closer ties of co-operation in order that they may present a united front in maintaining their status in the industry.

In his president's report, Mr. Schultz said that the officers of the association, in co-operation with other associations and distributors, were considering the assembling of definite information on the amount and effect of loss of revenue on Ethyl gasoline in event it is withdrawn from civilian consumption.

Secretary Gienapp said that the necessity for conserving mileage had caused a reduction in his travels over the state from 30 to 40 thousand miles a year to less than 1000 miles per month, which is why some of the jobbers had not seen him as often as they used to. But he emphasized that the association was very much alive and active.

Before close of the convention, Gerhard Goplerud of Osage, Ia., was elected vice president of the association. President John W. Schultz, Treasurer F. H. Hatch and Secretary Gienapp were re-elected. Seven new directors elected were: M. T. Jones, Iowa City; G. D. Finnigan, Cedar Rapids; Gerhard Goplerud, Osage; V. N. Smith, Ankeny; Fred Thiel, Britt; M. C. Clemmenson, Atlantic, and Walt Mohler, Schaller.

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Missouri Jobbers 'Reassured' by OPA and PAW

Special to NPN

JEFFERSON CITY, MO.—Orville D. Judd, OPA price executive, speaking for the first time before a group of middle western oil jobbers, told members of the Missouri Independent Oil Jobbers Assn. in annual convention here Feb. 24-25, that if any of them felt price restrictions were injuring them, their application for adjustment of margin would be taken up by OPA for consideration.

He reminded the jobbers, however, that the margin questionnaire prepared for circulation last fall was a failure, the jobbers evidencing a lack of interest, and not filling in and returning enough of them to justify their consideration as a complete picture of jobber circumstances.

Price controls, he said, are the main brake on inflation and are necessary, even though unpopular.

Jobbers Assured Share

Ernest L. Hughes, PAW Dist. 2 director of marketing, spoke to the jobbers at the Friday afternoon session on "Wartime Problems of the Jobber." He warned that maintenance of the present gallonage value of ration coupons depended on public and industry conservation of limited supplies and on what the military required, but said he saw no real reason for alarm.

If the scarcity of supplies reaches the desperate stage, he continued, and it becomes necessary to issue an allocations order, PAW will see to it that jobbers receive their fair share.

Critical shortage of manpower may hamper the distributing branch of the oil industry in some areas, he said, unless the majority of jobbers in the larger cities, or in counties, request a manpower survey to be made by the Dist. 2 manpower subcommittee, and obtain a "locally needed" declaration by WMC, which will stabilize their employes.

Gary Spencer, secretary, Missouri Petroleum Industries Committee, told the convention that men in the petroleum business can be an effective force for just taxation and sound legislation, for economical government, and for fair treatment of business. He said that the industry asked no special favors but insisted upon equality of treatment. After the war, he said, there will be great need for solidarity among oil men in meeting the common tax and legislative problems that will arise due to renewed search for revenue by government. Missouri oil men at that time, he said, should exercise the democratic right of petition in behalf of themselves and their customers and should carry on an educational campaign relating to tax and legislative matters.

Roy W. Blair was elected association president for the year. He served as vice president previously and Harry E. Milton, St. Louis, was elected to that office. Paul V. Brown was re-elected treasurer and acting executive secretary and Paul H. McMahan, secretary. Robert W. Hadlick, who is now in the Army Air Force at Scott Field, Belleville, Ill., was re-elected executive secretary and his leave of absence extended during his military service.

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Kansas Independent Dealers Protest Coupon Order

Special to NPN

WICHITA, Kans.—Independent Gasoline Distributors Assn., a group of independent operators licensed to do business in the state of Kansas, at a meeting in Hotel Lassen Feb. 21, voted to go on record as opposing OPA's present methods of rationing enforcement by requiring endorsement of coupons, according to H. L. Parker, association president.

"It was brought out repeatedly during the meeting by substantial business men of our group," he said, "that a high percentage of our membership had boys in the army, were buying bonds and were eager to bring the war to a close as early as possible, but that they would like to be recognized and considered by OPA as honest, legitimate, patriotic businessmen, trying to do a good job, but who could not be expected to do the impossible, which present endorsement methods of coupons seemed to be."

The association also went on record against an increase in the Kansas gasoline tax recently proposed by the Kansas Highway Commission, Parker said.

Alex Hotchkiss, state senator from Lyndon, said at the convention luncheon: "With demands for federal revenue necessarily heavy, there is a greater need than ever before for simplified tax laws, forms and procedure."

Andrew Schoeppel, governor of Kansas, spoke at the convention banquet on "Kansas Gasoline Shortages".

Association officers and directors elected for 1944 were: Howard L. Parker, Wichita, president; John B. Gabbert, Salina, vice president; Vernon Johnson, Wichita, secretary and treasurer.

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Oil Heat Institute Called to New York Meeting March 12

NPN News Bureau

NEW YORK—Postwar problems will receive major consideration here at the annual meeting of the Oil Heat Institute of America, Inc., March 12 to 14. The institute's advisory and postwar planning committee will have the full program on the opening day, March 12. On March 13 the distribution divisions will meet and on March 14 directors of the institute will map the policy program for the year.

F. B. Caldwell has become national secretary of the distribution division succeeding R. F. Horan. Mr. Caldwell has been secretary of the Burning Oil Distributors Assn. of Chicago for 11 years.

TO ALL

Natural Gasoline Men

Greetings

FROM THE

NATURAL GASOLINE SUPPLY MEN'S ASSOCIATION

We are looking forward to seeing you at the

TWENTY-THIRD ANNUAL CONVENTION

of the

NATURAL GASOLINE ASSOCIATION OF AMERICA

April 12-14, Baker Hotel, Dallas, Texas

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The Bristol Company
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Elliott Company
The Fisher Governor Company
The Foxboro Company
Frick-Reid Supply Corporation
Gasoline Plant Construction Corporation
Goulds Pumps, Inc.
D. W. Haering & Co., Inc.
Hanlon-Waters, Inc.
Hercules Motors Corporation
Ingersoll-Rand Company
Warner Lewis Company
The Marley Company, Inc.
C. A. Mathey Machine Works
Mid-Continent Engineering Company
Merco-Nordstrom Valve Company
Metric Metal Works
Midwest Piping & Supply Company
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National Tank Company
Naylor Pipe Company
The Oil & Gas Journal
Parkhill-Wade
The Petroleum Engineer
Petroleum Engineering, Inc.
Petroleum Refiner
Pittsburgh Equitable Meter Company
The Refinery Supply Company
Southern Supply Incorporated
Stearns-Roger Manufacturing Company
Taylor Instrument Companies
Tulsa Boiler & Machinery Company
Vinson Supply Company
Vortox Manufacturing Company
Walco Engineering & Construction Company
Walworth Company
Westcott & Greis, Inc.
Woobank Pump & Machinery Company
World Petroleum
Worthington Pump & Machinery Company
Wyatt Metal & Boiler Works
John Zink Company

JOBBERS ASK DATA

(*Continued from p. 5*)

the proportion of their Ethyl sales to sales of house-brand gasoline. By using the average margin over the entire state for both Ethyl and house-brand, he was able to furnish figures for the state of Kansas. These figures show loss in revenue would be $1,381,683.87.

Following is the questionnaire being distributed by the South Dakota Independent Oil Men's Assn. It is the same as the form being sent out by direction of N.C.I.P.A. except for the data relating to low flash tractor and power fuel at the bottom of the sheet.

FORM TO DETERMINE LOSS OF REVENUE IF PREMIUM GAS SHOULD BE DISCONTINUED YEAR OF 1943

1. Total Gas Gallons Sold .....
2. Less Regular Sold .....
3. Less Ethyl Sold .....
4. Gross Profit on Ethyl (Selling Price Less Laid Down Cost) .....
5. Gross Profit on Regular .....
6. Difference .....
7. Ethyl Gallons Sold (line 3) .....
8. Multiply by Difference (line 6) .....
9. Loss if Ethyl Discontinued .....
10. Divide loss (line 9) by gas gallons sold in 1943 (line 1) to determine amount of price increase needed if Ethyl were discontinued to offset profit now earned on Ethyl sales.
11. Price increase per gallon needed (line 10) to equal same revenue .....

.....
(Company Name)

.....
(Address)

.....
(City) (State)

Total Cost (line 9)

LOW FLASH TRACTOR AND POWER FUEL

1. Total Gallons Sold 1943 .....
2. Cost per gallon .....
3. Selling Price .....
4. Gross Profit per Gallon .....

PAW Extends Priority Aid To Certain Retailers

NPN News Bureau

WASHINGTON—PAW Feb. 24 announced that revisions of Preference Rating Orders P-98-B and P-98-E extend to oil operators who provide maintenance and repair service to retail and consumer outlets the right to use an AA-3 rating.

The two orders were revised, PAW explained, in order that this type of repair work by the petroleum industry would be brought to parity with the recently amended CMP Regulation 9A, which likewise assigns a rating of AA-3 to repairmen, and to assure centralized supervision by PAW in cases where critical materials are involved.

OPA Maps Plans For Rations Of 1944-45 Heating Oil

NPN News Bureau

WASHINGTON—Opening the first of three-week long series of conferences with industry and field officials, OPA Feb. 23 forecast probable need for continuing fuel oil rationing during the 1944-45 heating season, even if war in Europe ends this year.

The meeting was with the fuel oil industry advisory council, for the purpose of reviewing present ration system and suggesting revisions. Field sessions will follow in Concord, N. H., New York City, Atlanta, Detroit, Cincinnati and Chicago with OPA regional and district rationing chiefs, after which industry and representatives will meet here again March 15 and 16 to discuss ration plans for next season.

WAR ORDERS FOR THE OIL INDUSTRY

(*Continued from p. 14*)

cally named on a preference rating certificate take assigned rating. Special rules apply to split activities. Issued 2-18.

TIRE ALLOTMENT PLAN—R-1, Appendix IV—Truck-bus, tractor-implement, and industrial tires placed under allocation, to be distributed on quarterly basis among claimant agencies, parallelling Controlled Materials Plan procedure. Producer's production schedule becomes frozen on first day of each quarterly period, as outlined by Pri. Reg. 18, subject to further regulation by WPB. Issued 2-16.

Executive Orders

SURPLUS WAR PROPERTY ADMINISTRATION—EO 9425—Surplus War Property Administration established as part of Office of War Mobilization, to be administered by the Surplus War Property Administrator, appointed by Director of War Mobilization. Administrator will be assisted by Surplus War Property Policy Board made up of representative from various government agencies and departments.

Dept. of Labor, Wage-Hour Division

MINIMUM WAGE RULE REQUIREMENTS —Industry Committee 66 Recommendation — 40c hr. minimum rate approved for workers in petroleum and natural gas extraction industries. Every employer must keep posted conspicuously in each department the prescribed notice of this order, including clerical, maintenance, shipping, and selling departments; except that these departments are not included when operated in a physically segregated wholesaling or selling department selling purchased-for-resale articles for the majority of its sales. Issued 2-11, effective 3-20.

Defense Supplies Corp.

WAR EMERGENCY PIPELINES EXCEPTED FROM "VALUE AT ACTUAL ORIGIN" FORMULA—DSC Rev. Reg. 1, Am. 4—Limitation of compensable value of products to lowest of three formulae (normal origin value, ceiling applicable on shipment date, and prevailing market price) does not apply to products transported by War Emergency Pipelines System and purchased from DSC, thus permitting compensation on any take-off of products at Norris City, Ill. (terminal of 20-in. products line) for tank car movement to East Coast. Issued 2-24, effective 2-1.

CURRENT AND PREVAILING RATES GOVERN COMPENSABLE MOVEMENTS—DSC Notice to Applicants for Adjustments under Reg. 1—Computation of compensable movements must be based on most economical of available transportation methods, and barge costs are limited to prevailing full-barge maximum rates. All normal method costs based on current rate. Issued 2-24.

General Land Office

EXTENSION OF FIVE-YEAR LEASES—General Land Office Circular 1568—Five-year leases expiring before 12-31-44, maintained according to statutory requirements, extended to 12-31-44 if rentals are paid to that date and all other statutory regulations complied with. Approved 2-7.

Coming Meetings

MARCH

National Council of Independent Petroleum Assns., Hotel Severin, Indianapolis, Ind., Tues., March 7.

Indiana Independent Petroleum Assn., spring convention and oil war conference, Hotel Severin, Indianapolis, Wed-Thurs., Mar. 8-9.

American Petroleum Institute, Pacific Coast Dist., Div. of Production, Biltmore Hotel, Los Angeles, Cal., Wed., March 15.

Empire State Petroleum Assn., Inc., spring meeting, Hotel Onondaga, Syracuse, N. Y., Wed.-Thurs., Mar. 22-23.

Western Petroleum Refiners' Assn., 32nd annual meeting, Jefferson Hotel, St. Louis, Mo., Tues., March 28.

APRIL

Interstate Oil Compact Commission, New Orleans quarterly meeting, Roosevelt Hotel, New Orleans, La., Mon.-Tues., April 3-4.

Natural Gasoline Assn. of America, annual meeting, Baker Hotel, Dallas, Wed.-Fri., April 12-14.

American Petroleum Institute, Eastern Division, Div. of Production, Deshler-Wallick Hotel, Columbus, Ohio, Thurs.-Fri., April 13-14.

National Petroleum Assn., 41st semi-annual meeting, Hotel Cleveland, Cleveland, Ohio, Thurs.-Fri., April 20-21.

Michigan Petroleum Assn., 10th annual spring convention, Detroit-Leland Hotel, Detroit, Mich., Tues.-Wed., April 25-26.

Independent Petroleum Assn., mid-year directors meeting, Emery Hotel, Bradford, Pa., Thurs.-Sat., April 27-29.

MAY

American Petroleum Institute, Mid-Continent Dist., annual spring meeting, Mayo Hotel, Tulsa, Okla., Thurs.-Fri., May 25-26.

FORECAST ERA OF GREATER OIL USE

(*Continued from p. 4*)

said the potential market for natural gas at the destination end of the lines is ample to utilize their combined capacity.

On the basis of an average of 100 to 120 billion cubic feet per year, the gas marketed through these lines would amount to only 3% to 4% of the total consumption of natural gas in the U. S. at present, estimated in excess of 3 trillion cubic feet a year, and total deliveries through the lines in a 10-year period would be equal to only about 1% of the estimated present known reserves of gas in the U. S. There would appear, therefore, to be adequate supplies available for the lines, although there is involved the question of what may constitute the soundest uses of natural gas in this country.

The cost of gas at the source, plus the cost of transportation through the War Emergency lines to destination, including return on investment at the highest levels permitted, would make it possible to deliver the gas into Eastern distributing systems at an estimated price of 23c to 26c per MCF.

Forecasts Attractive Rates

Attractive rates to consumers, comparable to those in other Central Eastern areas where conversion to natural gas has occurred, could be established, he asserted.

The use of both Big Inch and Little Big Inch for gas service, rather than only one, would be an advantage from the standpoint of protection against emergency interruptions.

Postwar uses of the lines for crude oil and product present many complications, especially if there are enough or more than enough tankers to handle the Gulf-East Coast oil movements after the war.

T. E. Swigart, president of Shell Pipe Line Co., read a paper entitled "Postwar Uses of the War Emergency Pipe Line for Petroleum Transportation."

Pratt Hopeful on Reserves

Wallace E. Pratt, geologist and vice-president of the Standard Oil Co. (N. J.) was the speaker at the petroleum dinner Feb. 22. He said that total U. S. petroleum resources "far exceed our present proved reserves, and a moment's reflection makes it clear that the decrease in discovery rate over the past few years has been inevitable under prevailing conditions, however much of our total resources may remain to be discovered."

"As to the declining rate of discovery of new oil fields in the U. S. in recent years, our anxiety is relieved the moment we recognize that oil finding simply has been a casualty of war. Since the inception of the first period of national emergency, crude oil prices have been fixed at levels so low as to afford no possible incentive to the wildcatter to search for new fields. Since the day the U. S. found itself at war, lack of critical materials and lack of manpower have been added to the lack of price incentive to stifle any remaining effort to find new oilfields."

"Whenever the American wildcatter is again free to drill exploratory wells without restraint," he concluded, "and is given adequate materials and manpower, plus the stimulus of attractive crude oil prices, the rate of discovery of new oilfields will undoubtedly increase."

A somewhat different opinion than Mr. Pratt's was presented by William B. Heroy, president of the Society of Economic Geologists and PAW's director of foreign productions division. Mr. Heroy said: "In many areas oil resources are being depleted far more rapidly than would be considered sound practice under normal conditions. This would be a cause for concern in itself, but the gravity of the situation is increased by the recent decline in the rate of discovery of new underground supplies to take the place of those that are being so rapidly depleted.

"This falling off in new discoveries would give no cause for concern if it had been paralleled by a decline in exploratory activity. Such, however, is not the explanation. Over 15,000 wildcat wells were drilled during the last six years. In compliance with the desires of the government, wildcat drilling was intensified during the last two years. All this activity has resulted in the discovery of a record number of new fields and of new producing horizons in old fields, but the importance of these discoveries, measured in terms of volume of oil found, has gradually diminished. The size of the new fields found has been most disappointing."

At the petroleum dinner the Penrose Medal of the Society of Economic Geologists was awarded to Walter Curran Mendenhall, in recognition of his long and distinguished service as director of the U. S. Geological Survey.

The Anthony F. Lucas Medal was presented to Charles Van Ormer Millikan, chief engineer of the Amerada Petroleum Corp., of Tulsa.

The petroleum division of the institute will be headed by Winfield S. Morris, vice-president of East Texas Salt Water Disposal Co., Kilgore. Other division officers are Stuart E. Buckley, Humble production research department, associate chairman; H. F. Beardmore, Barnsdall, and Commander Victor H. Wilhelm, U.S.N.R., Naval Petroleum Reserves, Los Angeles, regional vice-chairman; Harold Vance, Texas A. & M., secretary-treasurer.

Committee chairmen include Walter Miller, vice-president of Continental Oil Co., Ponca City, refinery engineering; K. A. Covell, Pure Oil Co., Fort Worth, production engineering; Winthrop P. Haynes, Standard Oil Co. (N. J.), production; F. B. Plummer, University of Texas, production geology; A. G. Loomis, Shell Development Co., engineering research.

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FREEDOM OIL COMPANY
FREEDOM, PA.
PACIFIC COAST BULK PLANT AND WAREHOUSE
Los Angeles, California

Pennsylvania 'Gas' Cut 23%

Special to NPN

HARRISBURG, Pa. — Pennsylvanians, during 1943, consumed 1,045,767,823 gal. of taxable gasoline, compared with 1,371,506,896 gal. in 1942, according to a report issued by the state's department of revenue, bureau of liquid fuels tax. The decrease of 325,739,064 gal. represents a decline of 23.75% in 1943 use.

Tax-exempt gallons sold amounted to 20,600,852 gal. last year, compared with 17,920,206 gal. in 1942—an increase of 2,680,646 gal., or 14.96%.

Market Reports

MIDWEST — Less essential civilian outlets will suffer when spring call for gasoline begins to get underway because of refiners' inability to build the substantial storages needed over the winter, several agreed last week. Vague reports of gasoline being offered marketers considerably below ceiling were circulating but, in general, gasoline prices remained at ceiling for both marketers and refiners and no official changes in posting were reported. Spot sales of gasoline were confined mainly to sales made to companies supplying seller with crude.

Heating oils continued in strong demand last week with many refiners' supplies made up of daily production only, since storages have been absorbed by persistent call all season. Residual fuels eased somewhat in Chicago area and several refiners reported offering small quantities on open spot market for first time in several months but product, in general, remained tight. Refiners reported no price changes on any product.

° ° °

MIDCONTINENT—Decided increase has been felt in demand for Ethyl gasoline since cut in octane ratings of Ethyl and regular grades went into effect last November. Gasoline storages are not building up in sufficient quantities to take care of anticipated spring farm demand, reports indicate. Refiners say demand for kerosine and burning oils shows no letup.

Transporters in Kansas are predicting an acute shortage of transport truck transportation this summer, Kansas refiners say. Some Kansas transporters are reported moving to Texas where rates are higher.

Thirteen cars Grade 26-70 natural gasoline were reported sold at 4.75c f.o.b. Group 3. No open spot sales were reported f.o.b. Breckenridge; sellers quoted 4.375c during the week.

° ° °

PENNSYLVANIA — Lower field refiner reported raising price for No. 2 fuel 0.125c to 6.875c, leaving price range unaffected. Another refiner quoted the following new prices: 8.45c for "Q" gasoline, 7.5c for 45 w.w. kerosine, 7.75c for 47 w.w. kerosine, 7c for No. 2 fuel and 6.875c for 36-40 gravity fuel. Price ranges for all products were unchanged. Daily production of burning oils was said to be going for only contract customers and several refiners reported themselves behind in filling orders for kerosine. One refiner said he was paying 31.5c for 200 vis. 25 p.t. neutrals and selling it for 32c. Prices remained unchanged at current posted levels.

° ° °

GULF COAST—Refiners in Texas and other Gulf points continue to report products markets unchanged. All refined petroleum products are said to be critically low, and demand for light fuel oils in excess of availability. No price changes reported.

ATLANTIC COAST — Shortage of light fuel oils which has persisted at eastern points for past several weeks reported unchanged. Barge shipments at New York harbor are reported "few and far between", with tank car deliveries likewise curtailed. Situation at New England points is particularly critical, and many marketers are said to be transferring their shipments north to ease shortage.

Suppliers anticipating relief from 20-in. pipeline are hoping for deliveries via that line by early March to get them through winter's end. Quotations at all points unchanged.

CRUDE PRICES

Since changes in crude oil prices are so few, the 2 pages of crude oil price tables hereafter will be printed only when there are sufficient changes in prices to warrant.

In the meantime a record is being kept in the Cleveland office of NPN and OILGRAM from which the publishers will be glad to make proofs, or letters or affidavits as to what the prices are, and without charge to regular subscribers. Changes in crude oil prices will be specially noted in this market section when made.

Crude Price Changes

(No changes reported during week ended Feb. 28. For latest tables of crude prices see NPN Feb. 23, pages 61-62.

Summary of Daily Gasoline Prices (February 21 to February 28)

	Monday Feb. 28	Friday Feb. 25	Thursday Feb. 24	Wednesday Feb. 23	Tuesday Feb. 22
U. S. Motor (ASTM octane)					
76 octane Ethyl:					
Oklahoma	6.75	6.75	6.75	6.75	6.75
Mid-Western (Group 3 basis)	6.75 - 7.25	6.75 - 7.25	6.75 - 7.25	6.75 - 7.25	7
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	7	7	7	7	7
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	6.75 - 7 (2)	6.75 - 7 (2)	6.75 - 7 (2)	6.75 - 7 (2)	6.75 - 7 (2)
72 octane:					
Oklahoma	6	6	6	6	6
Mid-Western (Group 3 basis)	6	6	6	6	6
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	6	6	6	6	6
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	6	6	6	6	6
63-66 octane:					
Oklahoma	5.625 (2)	5.625 (2)	5.625 (2)	5.625 (2)	5 625 (2)
Mid-Western (Group 3 basis)	5.6 - 5.625	5.6 - 5.625	5.6 - 5.625	5 6 - 5.625	5.6 - 5.625
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.625 (1)	5.625 (2)	5.625 (2)	5.625 (2)	5.625 (2)
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.75 (1)	5.75 (1)	5.75 (1)	5.75 (1)	5.75 (1)
60 octane & below:					
Oklahoma	5.25	5.25	5.25	5.25	5.25
Mid-Western (Group 3 basis)	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.25	5.25	5.25	5.25	5.25
Motor Gasoline, 72 octane (ASTM)					
New York harbor	9.2 - 9.4	9.2 - 9.4	9.2 - 9.4	9.2 - 9.4	9.2 - 9.4
New York harbor, barges	9.1 - 9.3	9.1 - 9.3	9.1 - 9.3	9.1 - 9.3	9.1 - 9.3
Philadelphia district	9.2	9.2	9.2	9.2	9.2
Baltimore district	8.95	8.95	8.95	8.95	8 95
Motor Gasoline:					
Western Penna. Bradford-Warren:					
"Q" Gasoline, Min. 70 Oct. (ASTM)	7.75 - 8.95	7.75 - 8.95	7.75 - 8.95	7.75 - 8.95	7.75 - 8.95
Western Penna. Other Districts:					
"Q" Gasoline, Min. 70 Oct. (ASTM)	7.75 - 8.45	7.75 - 8.45	7.75 - 8.45	7.5 - 8.45	7.5 - 8.45

Refinery Operations

(American Petroleum Institute figures in thousands of barrels of 42 gallons each. Figures include reported totals plus an estimate of unreported amounts and are therefore on a Bureau of Mines basis.)

Districts	Daily Potential Refining Capacity Week Ended		Per Cent of Refining Capacity Reporting Week Ended		Daily Average Crude Runs to Stills Week Ended		Per Cent of Reporting Capacity Operated Week Ended	
	Feb. 19	Feb. 12	Feb. 19	Feb. 12	Feb. 19	Feb. 12	Feb. 19	Feb. 12
Combined**	2,448	2,448	90	90	2,138	2,081	87.3	85
Appalachian (Dist. No. 1)	130	130	83.9	83.9	100	91	76.9	70
Appalachian (Dist. No. 2)	47	47	87.2	87.2	50	50	106.4	106.4
Ind., Ill., Ky.	824	824	85.2	85.2	768	754	93.2	91.5
Okla., Kans., Mo.	416	416	80.1	80.1	348	357	83.7	85.8
Rocky Mt. (Dist. No. 3)	8	8	26.9	26.9	12	11	150	137.5
Rocky Mt. (Dist. No. 4)	141	141	58.3	58.3	92	87	65.2	61.7
California	817	817	89.9	89.9	832	797	101.8	97.6
Total U. S.—B. of M. Basis	4,831	4,831	87.1	87.1	4,340	4,228	89.8	87.5
U. S.—B. of M. Basis Feb. 20, 1943					3,668			

Districts	Gasoline Production at Refineries Inc. Natural Blended Week Ended		Stocks of Finished and Unfinished Gasoline Week Ended		Total Stocks Gas Oil & Distillates Week Ended		Total Stocks Residual Fuel Oil Week Ended	
	Feb. 19	Feb. 12	Feb. 19	Feb. 12	Feb. 19	Feb. 12	Feb. 19	Feb. 12
Combined**	6,380	6,172	36,919	36,060	15,388	16,755	15,184	15,088
Appalachian (Dist. No. 1)	294	258	2,059	2,029	738	762	170	158
Appalachian (Dist. No. 2)	179	152	1,207	1,241	356	141	215	223
Ind., Ill., Ky.	2,679	2,695	18,432	17,879	5,921	5,665	3,011	3,013
Okla., Kans., Mo.	1,266	1,238	7,881	7,844	1,696	1,720	1,250	1,248
Rocky Mt. (Dist. No. 3)	34	34	73	72	20	20	30	31
Rocky Mt. (Dist. No. 4)	340	334	1,920	1,801	365	355	582	566
California	2,154	2,218	15,440	15,396	9,225	9,436	32,523	32,126
Total U. S.—B. of M. Basis	13,326	13,101	83,931*	82,322	33,709	34,854	52,965	52,453
U. S.—B. of M. Basis Feb. 20, 1943	10,323		91,823		36,122		70,371	

*Finished 73,662,000 bbl.; Unfinished 10,269,000 bbl.
**Includes East Coast, Inland Texas, Texas Gulf, Louisiana Gulf, and North Louisiana-Arkansas districts.

U. S. Crude Oil Production

(American Petroleum Institute figures)

	WEEK ENDED Feb. 19 Barrels (Daily Average)	Feb. 12 Barrels (Daily Average)
Oklahoma	325,400	327,200
Kansas	268,050	281,750
Nebraska	1,100	1,100
Texas	1,909,650	1,909,650
Louisiana	360,300	360,300
Arkansas	78,750	78,800
Mississippi	42,600	43,950
Illinois	211,100	203,850
Indiana	12,450	14,350
Eastern (Ill., Ind. & Ky. excluded)	68,700	69,450
Kentucky	20,100	22,900
Michigan	53,500	53,400
Wyoming	95,400	98,500
Montana	20,950	20,950
Colorado	6,900	8,450
New Mexico	112,850	113,050
California	796,700	791,500
Total, U. S.	4,384,500	4,399,150

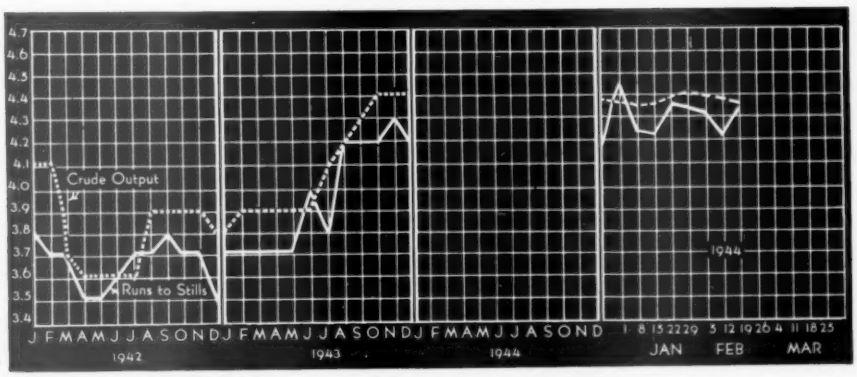
Crude Oil Stocks

(Bureau of Mines Figures in thousands of bbls.)

Grade or Origin	Feb. 19	Feb. 12	Change from Feb. 12
Penna. Grade	2,345	2,349	— 4
Other Appalachian	1,386	1,336	+ 50
Lima-Michigan	943	912	+ 31
Illinois-Indiana	13,133	12,631	+502
Arkansas	2,873	3,008	—135
Kansas	7,629	7,993	—364
Louisiana:	14,653	14,877	—224
Northern	4,345	4,531	—186
Gulf Coast	10,308	10,346	— 38
Mississippi	1,071	949	+122
New Mexico	7,467	7,281	+186
Oklahoma	32,150	32,604	—454
Texas:	115,353	114,992	+361
East Texas	23,135	23,770	—635
West Texas	29,593	29,649	— 56
Gulf Texas	34,877	34,291	+586
Other Texas	27,748	27,282	+466
Panhandle	6,409	6,493	— 84
North	5,771	5,513	+258
South	5,854	5,592	+262
Other	9,714	9,684	+ 30
Rocky Mountain	10,472	10,497	— 25
California	26,662	27,321	—659
Foreign	1,374	1,456	— 82
Total gasoline-bearing in U. S.	237,511	238,206	—695
Heavy in California	6,662	6,666	— 4

Crude Production & Runs to Stills

(Millions of Barrels)



N.P.N. Gasoline Index

	Dealer T.W. Cents Per Gal.	Tank Car Cents Per Gal.
Feb. 28	10.51	6.65
Month ago	10.43	6.66
Year ago	10.33	6.67

Dealer index is an average of "undivided" dealer prices, ex-tax, in 50 cities.

Tank car index is weighted average of following wholesale markets for regular-grade gasoline, FOB refineries or terminals: Okla., Mid-Western, W. Penna., Calif., N. Y. Harbor, Philadelphia, Jacksonville, Boston and Gulf Coast.

Pennsylvania Crude Runs

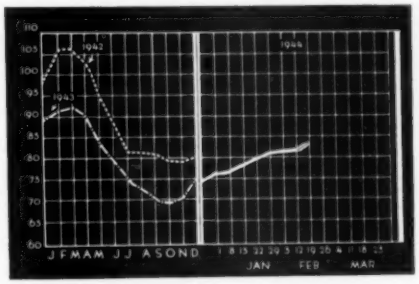
(Compiled by National Petroleum Assn. from reports of all companies refining Pennsylvania crude. Figures in bbls.)

DAILY AVERAGE

Week Ended Feb. 19, 1944	Week Ended Feb. 12, 1944	Week Ended Feb. 20, 1943
65,779	67,226	78,797

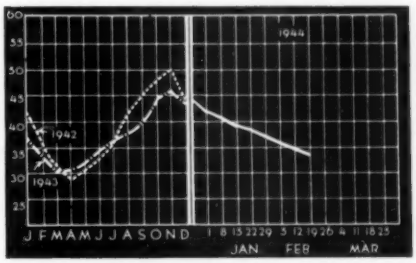
Gasoline Stocks

(Millions of Barrels)



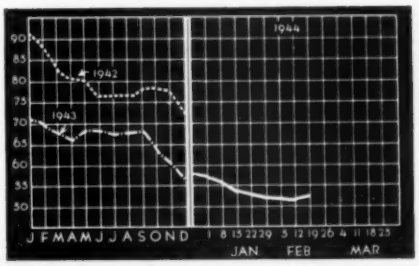
Gas Oil & Distillate Stocks

(Millions of Barrels)



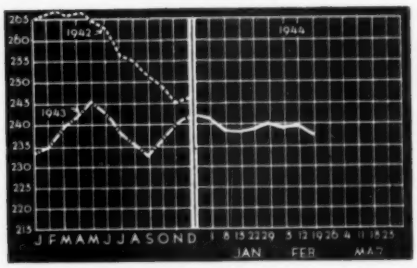
Residual Fuel Oil Stocks

(Millions of Barrels)



Crude Oil Stocks

(Millions of Barrels)



OIL PRICE SECTION

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At Refineries and Terminals and by Tank Wagon

Prices herewith are reproduced from Platt's *OILGRAM* Daily Oil Price Service, associated with National Petroleum News, whose representatives in all *NPN-OILGRAM* offices devote their time exclusively to reporting oil industry prices everywhere.

Prices shown are actual sales prices, or quotations meaning sellers' general offers or posted prices; for current sales and shipment; for the business day or period stated; except Tank Wagon prices, prices are for bulk lots such as tank car and motor transport; barge or tanker cargo lot prices are identified; FOB refineries or terminals; in cents per gal. except where shown in bbls. of 42 gals.; ex all fees and taxes; for crude oil and its products lawfully produced and transported; reported as received by *OILGRAM* and National Petroleum News but not guaranteed; for subscribers' private use only and not for resale or distribution or publication. For further details of price conditions apply to any *NPN-OILGRAM* office or see back of any *OILGRAM* Price Service invoice.

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Refinery Prices

Gasoline —U. S. Motor (A S T M) except where otherwise specified

Prices in Effect	Feb. 28	Feb. 21
OKLAHOMA		
76 oct. Ethyl	6.75	6.75
72 oct.	6	6
63-66 oct.	5.625 (2)	5.625 (2)
60 oct. & below	5.25	5.25
60-62, 400 e.p.	5.25 (1)	5.25 (1)
MID-WESTERN (Group 3 basis)		
76 oct. Ethyl	6.75 - 7.25	6.75 - 7.25
72 oct.	6	6
63-66 oct.	5.6 - 5.625	5 6 - 5 625
60 oct. & below	5.2 - 5.25	5.2 - 5 25
N. TEX. (For shpt. to Tex. & N. M. dest'ns.)		
76 oct. Ethyl	7	7
72 oct.	6	6
63-66 oct.	5.625 (1)	5.625 (1)
60 oct. & below	5.2 - 5.25	5.2 - 5.25
60-62, 400 e.p.	5.375 (1)	5.375 (1)
W. TEX. (For shpt. to Tex. & N. M. dest'ns.)		
76 oct. Ethyl	6.75 - 7 (2)	6.75 - 7 (2)
72 oct.	6	6
63-66 oct.	5.75 (1)	5.75 (1)
60 oct. & below	5.25	5.25
CENT. W. TEX. (Prices to truck transports)		
76 oct.	7 (2)	7 (2)
72 oct.	6 (2)	6 (2)
67-69 oct.	....	....
62 oct. & below	5.25 (2)	5.25 (2)
AMARILLO, TEX. (For shpt. to W. Okla. & Tex. differential territory.)		
60 oct. & below.	No Price	No Price
60-62, 400 e.p.	No Price	No Price
KANSAS (For Kansas destinations only)		
76 oct. Ethyl	7.25-7.5 (2)	7.25-7.5 (2)
72 oct.	6.25 - 6.3	6.25 - 6.3
63-66 oct.	5.9 (2)	5.9 (2)
60 oct. & below.	5.5	5.5
ARK. (For shipment to Ark. & La.)		
76 oct. Ethyl	7 (1)	7 (1)
72 oct., leaded	6 (1)	6 (1)
70-72 oct. "	5.875 (1)	5.875 (1)
62 oct. "	.....	.....
60 oct. & below, leaded	5.25 (1)	5.25 (1)
WESTERN PENNA. (Motor gasoline)		
Bradford-Warren:		
"Q" Gasoline, Min. 70 Oct. (ASTM)	7.75 - 8.95	7.75 - 8.95
Other districts:		
"Q" Gasoline, Min. 70 Oct. (ASTM)	7.75 - 8.45	7.75 - 8.45
CENTRAL MICHIGAN (FOB Central Mich. refinery group basis for shpt. within Mich.; shpts. may originate at plants outside Central group.)		
U.S. Motor: (Oct. ASTM):		
72 oct.	8 - 8.5	8 - 8.5
67-69 oct.	....	....
Str. run gasoline, excluding Detroit shpt.	6	6
OHIO (S. O. Ohio quotations for statewide delivery and subject to exceptions for local price disturbances).		
72 oct.	8.375	8.375
CALIFORNIA U.S. Motor:		
76 oct. (Ethyl)	7.5 - 8.75	7.5 - 8.75
70-72 oct. (regular)	6.5 - 7.75	6.5 - 7.75
65 oct. & below (3rd grade)	6.5 - 6.75	6.5 - 6.75

Kerosine, & Gas Fuel Oils

Prices in Effect	Feb. 28	Feb. 21
OKLAHOMA		
41-43 grav. w.w.	4.375	4.375
42-44 grav. w.w.	4.5	4.5
Range Oil	4	4
No. 1 P.W.	3.875	3.875
No. 1 straw	....	....
No. 2 straw	3.625	3.625
No. 3 fuel	3.5 (2)	3.5 (2)
U. G. I. Gas Oil	....	....
No. 6 fuel	....	....
14-16 fuel	$0.97 (2)	$0.97 (2)
MID-WESTERN (Group 3 basis)		
41-43 grav. w.w.	4.375	4.375
42-44 grav. w.w.	4.5	4.5
Range Oil	4 - 4.1	4 - 4.1
No. 1 p.w.	3.875	3.875
No. 2 straw	3.625	3.625
No. 3	3.5 (1)	3 5 (1)
No. 5	$0.85 (1)	$0.85 (1)
No. 6	$0.80 (2)	$0.80 (2)
N. TEX. (For shpt. to Tex. & N. M. dest'ns.)		
41-43 grav. w.w.	4.375	4.375
42-44 grav. w.w.	4.5 (1)	4.5 (1)
No. 1 P.W.	3 875 (1)	3.875 (1)
AMARILLO, TEX. (For shpt. to W. Okla. & Tex. differential territory.)		
42-44 grav. w.w.	4.5 (1)	4.5 (1)
No. 1 straw	No Price	No Price
KANSAS (For Kansas destinations only).		
41-43 grav. w.w.	No Price	No Price
42-44 grav. w.w.	4.7 - 4.75	4.7 - 4.75
No. 1 p.w.	4.1	4.1
No. 6 fuel	$0 85	$0 85
ARK. (For shipment to Ark. and La.)		
41-43 grav. w.w.	....	....
42-44 w.w. kero	4.5 (1)	4.5 (1)
No. 1	4 (1)	4 (1)
No. 2	3 625 (1)	3 625 (1)
No. 3 fuel	3.5 (1)	3.5 (1)
Tractor fuel, for shpt. to Ark. points only	5.125 (1)	5.125 (1)
Diesel fuel 52 & below	4 (1)	4 (1)
Diesel fuel 58 & above	4.25 (1)	4.25 (1)
WESTERN PENNA.		
Bradford-Warren:		
45 grav. w.w.	6.55 - 8.05	6.55 - 8.05
46 grav. w.w.	6 675 (1)	6 675 (1)
No. 1 fuel	6.875- 8.05	6.875-8.05
No. 2 "	6 75 -7 625(2)	6 75 -7 625(2)
No. 3 "	6.75 -7.75 (2)	6.75 -7.75 (2)
36-40 gravity	6.625-6 75 (2)	6.625-6.75 (2)
Other districts:		
45 grav. w.w.	7.25 - 7.925	7.25 - 7.925
46 grav. w.w.	7.25 - 7.625	7.25 - 7.625
47 grav. w.w.	7.375- 7.875	7 375- 7.875
No. 1 fuel	6.875- 7.375	6 875- 7.375
No. 2 "	6.75 - 7.375	6.75 - 7.375
No. 3 "	6.75 - 7.375	6.75 - 7.375
36-40 grav. Pittsburgh dist. prices excluded	6.625- 7.375	6.625- 7.375
CENTRAL MICHIGAN (FOB Central Mich. refinery group basis for shpt. within Mich.; shpts. may originate at plants outside Central group.)		
47-49 gravity w.w.	5.8 - 6	5.8 - 6
P.W. Distillate	5.5	5.5
No. 3 gas oil, Straw	5	5
U.G.I. gas oil	4.5 (2)	4.5 (2)
Fuel Oils (*Vis. at* 100).		
300-500 Vis	....	....
100-300 Vis	4.5	4.5
OHIO (S. O. quotations for statewide delivery)		
Kerosine	7	7
CALIFORNIA		
40-43 grav. w.w.	5 - 7	5 - 7
San Joaquin Valley:		
Heavy fuel	$1.10 (2)	$1.10 (2)
Light fuel	$1.20 (2)	$1.20 (2)
Diesel fuel	4 (2)	4 (2)
Stove dist.	5 (2)	5 (2)
Los Angeles:		
Heavy fuel	$1.10 (2)	$1.10 (2)
Light fuel	$1.20 (2)	$1.20 (2)
Diesel fuel	4 (2)	4 (2)
Stove dist.	5	5
San Francisco:		
Heavy fuel	$1.15 (1)	$1.15 (1)
Light fuel	$1.25 (1)	$1.25 (1)
Diesel fuel	4.5 (1)	4.5 (1)
Stove dist.	5.5 (1)	5.5 (1)

NOTE: All above heavy fuels meet Pacific specification 400; light fuel, spec. 300; Diesel fuels, spec. 200; and stove distillate, spec. 100.

Lubricating Oils

Prices in Effect	Feb. 28	Feb. 21
WESTERN PENNA.		
Prices are for sales made, or offers reliably reported, to jobbers & compounders only.		
Viscous Neutrals—*No. 3 col. Vis. at* 70°*F.*		
200 Vis. (180 at 100°) 420-425 fl.		
0 p.t.	35 (1)	35 (1)
10 p.t.	34 (1)	34 (1)
15 p.t.	33 (1)	33 (1)
25 p.t.	28-32.5	28-32.5
150 Vis. (143 at 100°) 400-405 fl.		
0 p.t.	33 (1)	33 (1)
10 p.t.	32 (1)	32 (1)
15 p.t.	31 (1)	31 (1)
25 p.t.	26-30.5	26-30.5
Cylinder Stocks		
Brt. stk., 145-155 *sis. at* 210°, 540-550 fl., *No. 8 col.*		
10 p.t.	30.5 (1)	30.5 (1)
15 p.t.	29.5 (1)	29.5 (1)
25 p.t.	25	25
600 S.R. filterable.	15	15
650 S.R.	15.5	15.5
600 fl	16	16
630 fl	17	17
MID-CONTINENT (F. o. b. Tulsa)		
Neutral Oils (*Vis. at* 100° *F. 0 to* 10 *P.P.*)		
Pale Oils:		
Vis. Color		
60-85—No. 2	8	8
86-110—No. 2	8.5	8.5
150—No. 3	14.5	14.5
180—No. 3	15	15
200—No. 3	15	15
250—No. 3	16-16 5	16-16 5
280—No. 3	17	17
300—No. 3	18	18
Red Oils:		
180—No. 5	15 (1)	15 (1)
200—No. 5	15 (1)	15 (1)
280—No. 5	No Price	No Price
300—No. 5	17.5 (2)	17.5 (2)

Note: Viscous Neutrals, 15-25 p.p. generally are quoted 0.5c under 0-10 p.p. oils. Non-viscous oils, 15-25 p.p.; generally are quoted 0.25c under 0-10 p.p. oils.

NOTE—Discounts of 1c for contracts and 1c and 2c and sometimes more off in addition, to "meet competition" are generally being allowed from these posted prices on "conventional" oils.

Bright Stock—*Vis. at* 210°		
200 Vis. D.	27 (1)	27 (1)
150-160 Vis. D:		
0 to 10 p.p.	23	23
10 to 25 p.p.	22.5-23	22.5-23
25 to 40 p.p.	23 (1)	23 (1)
150-160 Vis. E.	22 (1)	22 (1)
120 Vis. D:		
0 to 10 p.p.	22 (2)	22 (2)
600 S.R. Dark Green	8.5 (1)	8.5 (1)
600 S.R. Olive Green	10-11 (2)	10-11 (2)
631 S.R.	....	....
Black Oil	5.5 (1)	5.5 (1)
SOUTH TEXAS Neutral Oils		
Pale Oils (*Vis. at* 100°*F.*)		
Vis. Color		
100 No. 1½-2½	6.5	6.5
200 No. 2-3	8.75	8.75
300 No. 2-3	9.25	9.25
500 No. 2½-3½	10	10
750 No. 3-4	10.25	10.25
1200 No. 3-4	10.375	10.375
2000 No. 4	10.5	10.5

(Continued on next page)

NOTE—Parenthetical figures after prices indicate number of companies quoting when less than three companies are quoting.

NOTICE—Owing to great demand, refiners generally limit quotations to regular customers and refuse bids, though higher, from others. Refiners' prices and sales shown) bids reported in market leads.

Refinery Prices (Continued)

Prices in Effect	Feb. 28	Feb. 21
Red Oils:		
100 No. 5-6	6.5 (2)	6.5 (2)
200 No. 5-6	8.75	8.75
300 No. 5-6	9.25	9.25
500 No. 5-6	10	10
750 No. 5-6	10.25	10.25
1200 No. 5-6	10 375	10 375
2000 No. 5-6	10.5	10.5

CHICAGO (From Mid-Continent p.l. crude.) Neutral oils *vis. at* 100° *F. 0 to* 10 *p. p.*

Pale Oils Vis. Color		
60-85—No. 2	9.5 (1)	9.5 (1)
86-110—No. 2	10 (1)	10 (1)
150—No. 3	15.5 (1)	15.5 (1)
180—No. 3	16 (1)	16 (1)
200—No. 3	16 (1)	16 (1)
250—No. 3	17 (1)	17 (1)
Red Oils:		
180—No. 5	16 (1)	16 (1)
200—No. 5	16 (1)	16 (1)
250—No. 5	17 (1)	17 (1)
280—No. 5	18 (1)	18 (1)
300—No. 5	18.5 (1)	18.5 (1)

Note: Viscous oils, 15 to 30 p.p. are quoted 0.5c lower: 60-85 and 86-110 No. 2 non-viscous oils, 15 to 30 p.p., 0.25c lower.

Unfiltered Steam Refined: (*Viscosity at* 210°)		
140	11.5 (1)	11.5 (1)
160	12.5 (1)	12.5 (1)
200	13.5 (1)	13.5 (1)
Bright stocks, 160 *vis. at* 210 *No.* 8 *color:*		
0 to 10 p.p.	24 (1)	24 (1)
15 to 25 p.p.	23.5 (1)	23.5 (1)
30 to 40 p.p.	21.5 (1)	21.5 (1)
E filtered Cyl. Stock	15.5 (1)	15.5 (1)

Note: To obtain prices delivered in Chicago, add 0.25c per gal.

Natural Gasoline

(Group 3 & Breckenridge prices are to blenders on freight basis shown below. Shipments may originate in any Mid-Continent manufacturing district.)

FOB GROUP 3

Grade 26-70 ..... 4.75 (Quote) 4.75 (Sale)

FOB BRECKENRIDGE

Grade 26-70 ..... 4.375 (Quote) 4.375 (Quote)

CALIFORNIA (FOB plants in Los Angeles basin)

21 pound vapor pressure for blending .... 4.75– 5.375 4.75 – 5.375

Naphtha and Solvent

(*FOB Group* 3)

Stoddard solvent	6.625	6.625
Cleaners' naphtha	7.125	7.125
V.M.&P. naphtha	7 1 – 7.125	7.1 – 7.125
Mineral spirits	6 1 – 6.125	6.1 – 6.125
Rubber solvent	7.1 – 7.125	7.1 – 7.125
Lacquer diluent	7 375– 8.125	7 375– 8.125
Benzol Diluent	7 875– 8.625	7 875– 8.625

WESTERN PENNA.

Bradford-Warren District:

Stoddard Solvent 7.5 (1) 7 5 (1)

Other Districts:

Untreated naphtha	7 – 7.25	7 – 7.25
Stoddard solvent	7.25 – 8	7.25 – 8

OHIO (S. O. quotations for statewide delivery): V.M.&P. naphtha, D C. naphtha, Varnolene & Sohio solvent 10 10
Rubber solvent ... 9 9

Wax

WESTERN PENNA. (Bbls. C.L.)

White Crude Scale:

122-124 A.m.p.	4.25 (2)	4 25 (2)
124-126 A.m.p.	4.25	4.25

OKLAHOMA (C.L. FOB Refinery)

Semi-refined:

128 AMP min., white, 50 kilo bags	No Price	No Price
132-134 AMP, bbls.	5.25 (1)	5.25 (1)

CHICAGO (FOB Chicago district refinery of one refiner, in bags, carloads. Carloads, slabs loose 0.4c less. Melting points are EMP (ASTM) methods; add 3° to convert into AMP.)

Fully refined:

122-124 (bags only)	5 6	5.6
125-127	6	6
127-129	6.25	6.25
130-132	6.55	6.55
132-134	6.8	6.8
135-137	7.55	7.55

Petrolatums

WESTERN PENNA. (Bbls., carloads; tank cars, 0.5c per lb. less.)

Snow White	6.125– 7.25	6.125– 7.25
Lily White	5.375– 6.25	5.375– 6.25
Cream White	4.375– 5.5	4.375– 5.5
Light Amber	3.375– 4	3.375– 4
Amber	3.125– 3.75	3.125– 3.75
Red	3 – 3.5	3 – 3.5

Tank Wagon Prices

Commercial or consumer tank car, tank wagon, dealer, and service station prices for gasoline **do not include** *taxes; they do, however, include inspection fees as shown in general footnote. Gasoline taxes, shown in separate column, include 1.5c federal, and state taxes; also city and county taxes as indicated in footnotes. Kerosine tank wagon prices also do not include taxes; kerosine taxes where levied are indicated in footnotes. Dealer discounts are shown in footnotes. Theseprices in effect Feb.* 28, 1944 *as posted by principal marketing companies at their headquarters offices, but subject to later correction.*

S. O. N. J.

Esso (*Regular Grade*)	Consumer Tank Wagon	Dealer T.W.	Gaso-line Taxes	Kero-sine T.W.
*Atlantic City, N. J.	10.2	10.7	4.5	10
*Newark, N. J.	10.2	10.7	4.5	10
Annapolis, Md.	10.55	11.05	5.5	....
Baltimore, Md.	9.95	10.45	5.5	10.8
Cumberland, Md.	11.35	11.85	5.5	12.3
Washington, D. C.	10.2	10.7	4.5	11.3
Danville, Va.	11.65	12.15	6.5	12.55
Norfolk, Va.	10.45	10.95	6.5	12.3
Petersburg, Va.	10.75	11.25	6.5	13.3
Richmond, Va.	10.75	11.25	6.5	13.3
Roanoke, Va.	11.95	12.45	6.5	12.8
Charleston, W. Va.	12.25	12.75	6.5	13.6
Parkersburg, W. Va.	11.55	12.05	6.5	13.3
Wheeling, W. Va.	11.55	12.05	6.5	13.9
Charlotte, N. C.	12.1	12.6	7.5	11.6
Hickory, N. C.	12.65	13.15	7.5	12.6
Mt. Airy, N. C.	12.5	13.0	7.5	11.8
Raleigh, N. C.	11.85	12.35	7.5	12.6
Salisbury, N. C.	12.15	12.65	7.5	13.0
Charleston, S. C.	10.95	11.45	7.5	....
Columbia, S. C.	11.8	12.3	7.5	....
Spartanburg, S. C.	12.5	13.0	7.5	....

	Mineral Spirits T.W.	V.M.&P. T.W.
Newark, N. J.	13	14.5
Baltimore, Md.	15.5	....
Washington, D. C.	15.5	....

Fuel Oils—T.W.	No. 1	No. 2	No. 3
Atlantic City, N. J.	10	9	9
Newark	10	9	9
Annapolis, Md.	...	...	...
Baltimore	9.8	9	9
Washington, D. C.	10.3	9.4	9.4
Norfolk, Va.	10	8.8	8.8
Petersburg	10.3	9	...
Richmond	10.3	9	9
Charlotte, N. C.	10.6	10.4	...
Hickory, N. C.	....	10	...
Raleigh	11.6	10.1	...
Charleston, S. C.	....	9	...
Columbia	....	10	...
Spartanburg	....	10.8	...

*Effective Aug. 5, '42 minimum retail resale price of 14.2c posted thru New Jersey. Discounts;

Esso gasoline—to undivided dealers, 0.5c off dealer t.w.

Kerosine—1c off t.w. price for 25 gals. or more, under contract thru territory (Baltimore city contract not necessary) except no discount in state of New Jersey.

Naphthas—To buyers taking following quantities at one time: Newark, 2c per gal. on 200 gals. or more, less than 200 gals. 0.5c higher price; Baltimore, 2c off on 25 to 100 gals. and 3c on over 100 gals.; Washington, 2c off to contract buyers.

(N.B. Prices are Continental's "structural" prices. Prices do not reflect temporary reductions made to meet local competition.)

Notice

These prices include inspection fees on both gasoline and kerosine unless otherwise specified per gallon as follows:

Ala. 1/40c on gasoline, 1/2c on kerosine; Ark. 1/20c; Fl. 1/8c; Ill. 3/100c; Ind. 1/5c in lots of 25 bbls. or less. 2/25c in lots of more than 25 bbls.; Kans. 1/50c; La. 1/32c; Minn. 7/200c; Mis. 1/50c; Neb. 3/100c; Nev. gasoline 1f20c; N. C. 1/4c; N. Da. 1/20c; Okla. 2/25c; S. Car. 1/8c; S. Da. 1/20c; Tenn. 2/5c; and Wisc. 3/100c.

Kerosine inspection fees only: Iowa 3/50c; Mich. 1/5c per gal.

CONT'L OIL

	Conoco Bronz-z-z (*Reg.*)	Demand (*3rd Grade*) †Tank Wagon	Gaso-line Taxes	Kero-sine T.W.
Denver, Col.	11	10	5.5	11
Grand Junc., Col.	12	11	5.5	12
Pueblo, Col.	10.5	9.5	5.5	10.5
Casper, Wyo.	11.5	10.5	5.5	12
Cheyenne, Wyo.	11	10	5.5	11.5
Billings, Mont.	12.5	11.5	6.5	12.5
Butte, Mont.	13.5	12.5	6.5	13.5
Great Falls, Mont.	12.5	11.5	6.5	12.5
Helena, Mont.	13	12	6.5	13
Salt Lake City, Utah	13.5	12.5	5.5	14.5
Boise, Ida.	14.1	13.1	6.5	16.5
Twin Falls, Ida.	15.6	14.6	6.5	17
Albuquerque, N. M.	10	9	*7	9.5
Roswell, N. M.	9.5	8.5	*7	9
Santa Fe, N. M.	10.5	9.5	*7.5	10
Ft. Smith, Ark.	9.5	9.25	*7	9.5
Texarkana, Ark.	9	8	*5.5	9
Muskogee, Okla.	9.5	8.5	7	8.5
Oklahoma City, Okla.	9.5	8.5	7	8.5
Tulsa, Okla.	9.5	8.5	7	8.5

*Taxes: In gasoline tax column are included these city taxes—Albuquerque, & Roswell, 0.5c, Santa Fe, 1c. Texas 4c state tax applies within city limits of Texarkana, Ark.; Okla. 5.5c state applies within city limits of Ft. Smith, Ark.

†To consumers & Dealers.

S. O. NEB.

(*Regular Grade*)	T.W.	Dealer	Gaso-line Taxes	Kero-sine T.W.
Omaha	11.4	9.6	6.5	10.1
McCook	12.0	10.1	6.5	10.5
Norfolk	11.9	10.4	6.5	10.6
North Platte	12.2	10.6	6.5	11
Scottabluff	12.9	10.2	6.5	10.5

Standard Gasoline (*Regular Grade*)
Flight Gasoline (*Third Grade*)

S. O. CAL.

	Standard Posted Net Tank Truck	Standard Posted Re-tail	Flight Posted Net Tank Truck	Flight Posted Re-tail	Gaso-line Taxes
San Francisco, Cal.	10	14	9	12	4.5
Los Angeles, Cal.	9.5	13.5	8.5	11.5	4.5
Fresno, Cal.	11	15	10	13	4.5
Phoenix, Ariz.	12	16	10	13	6.5
Reno, Nev.	12	16	11	14	5.5
Portland, Ore.	10.5	14.5	9.5	12.5	6.5
Seattle, Wash.	10.5	14.5	9.5	12.5	6.5
Spokane, Wash.	12.5	16.5	11.5	14.5	6.5
Tacoma, Wash.	10.5	14.5	9.5	12.5	6.5

Std. Aviation 73

	Posted Net Tank Truck	Gasoline Taxes	Kerosine Tank Truck
San Francisco, Cal.	12.5	4.5	11.5
Los Angeles, Cal.	12	4.5	10
Fresno, Cal	13.5	4.5	12.5
Phoenix, Ariz.	14.5	6.5	12.5
Reno, Nev.	14.5	5.5	13.5
Portland, Ore.	13	6.5	13.8
Seattle, Wash.	13	6.5	13.8
Spokane, Wash.	16	6.5	16.8
Tacoma, Wash.	13	6.5	13.8

Resale & Commercial: T.C. deliveries 0.25c per gal. off posted net tank truck.

Commercial: Retail deliveries, and/or tank truck deliveries of less than 40 gals., 4c per gal. above posted net tank truck price for Standard Aviation and Standard Gasoline, and 3c per gal. above posted net tank truck for Flight Gasoline, except single deliveries of less than 40 gals. to Marine trade only, which are billed at posted net tank truck price.

TEXAS CO.

	Gasoline—Dealer T.W. Fire-Chief (*Regular*)	Indian (*3rd Grade*)	Gaso-line Taxes
Dallas, Tex.	7.5	6.5	5.5
Ft. Worth, Tex.	7.5	6.5	5.5
Wichita Falls, Tex.	8.5	7.5	5.5
Amarillo, Tex.	8.5	7.5	5.5
Tyler, Tex.	8.5	7.5	5.5
El Paso, Tex.	11	10.5	5.5
San Angelo, Tex.	8.5	7.5	5.5
Waco, Tex.	8.5*	7*	5.5
Austin, Tex.	8.5	7.5	5.5
Houston, Tex.	8.5	7.5	5.5
San Antonio, Tex.	8.5	7.5	5.5
Port Arthur, Tex.	8.5	7.5	5.5

*Less 1c temporary allowance to all dealers.

(Continued on next page)

Tank Wagon Prices—Continued

S. O. IND.

Red Crown (*Regular Grade*)
Blue Crown (*Third Grade*)

	Red Dealer Prices Crown Cons. T.W.	Red Crown	Blue Crown	Gaso-line Taxes	Kero-sine T.W.
Chicago, Ill.	11.6	9.6	9.1	4.5	10.6
Decatur, Ill.	11.6	9.6	8.7	4.5	10.3
Joliet, Ill.	11.9	10.3	9.2	4.5	10.6
Peoria, Ill.	11.7	9.9	9.7	4.5	10.4
Indianapolis, Ind.	11.6	10.1	9.6	5.5	10.1
Evansville, Ind.	11.4	9.9	8.6	5.5	9.9
South Bend, Ind.	12	10.5	10	5.5	10.5
Detroit, Mich.	11.4	9.9	9.4	4.5	10
Grand Rapids, Mich.	11.4	9.9	9.4	4.5	9.9
Saginaw, Mich.	11.4	9.9	9.4	4.5	9.9
Green Bay, Wis.	12.2	10.7	10.2	5.5	10.9
Milwaukee, Wis.	12.1	10.6	10.1	5.5	10.8
La Crosse, Wis.	11.9	10.4	9.9	5.5	10.6
Minneapolis - St. Paul.	11.9	10.4	9.9	5.5	10.6
Duluth, Minn.	12.2	10.7	10.2	5.5	10.9
Mankato, Minn.	11.9	10.4	9.9	5.5	10.6
Des Moines, Ia.	11.4	9.9	9.4	4.5	*10.1
Mason City, Ia.	11.7	10.2	9.7	4.5	*10.4
St. Louis, Mo.	11.0	9.5	9.3	*4.5	10.1
Kansas City, Mo.	11.0	9.5	8.6	*4.5	9.7
St. Joseph, Mo.	11.2	9.7	9.2	*4.5	9.9
Fargo, N. D.	12.9	11.4	10.9	5.5	11.6
Huron, S. D.	12.3	10.8	10.3	5.5	11
Wichita, Kans.	10.3	8.8	7.2	4.5	9.0

Stanavo Aviation 73 Octane
Withdrawn Jan. 1, 1944.

	Oleum Spirits	V.M.&P. Naphtha	Stani-sol	*Taxes
(Prices are base prices before discounts)				
Chicago	13.5	13.8	12.8	4.5
Detroit	15.8	15	16.3	4.5
K. C., Mo.	13.3	14.3	13.8	1.5
St. Louis, Mo.	13.7	14.7	13.2	1.5
Milwaukee	14.4	15.4	14.9	5.5
Minneap'lis	14.2	15.2	13.5	5.5

Fuel Oils T.W.
Chicago

	Standard Heater Oil
1-99 gals.	9.3
100-149 gals.	8.3
150 gals. & over	7.8

	Stanolex Furnace Oil
1-99 gals.	8.8
100-149 gals.	7.8
150-399 gals.	7.8
400 gals. & over	7.3

	Stanolex Fuel Oil A
1-99 gals.	8.3
100-399 gals.	7.3
400-749 gals.	6.3
750 gals. & over	5.55

	Stanolex Bunker C Fuel Oil
1-399 gals.	6.8
400-999 gals.	5.8
1000 gals. & over	4.8

Other Points Indianapolis	Stanolex Furnace Oil
1-99 gals.	9.0
100 gals. & over	8.0
Detroit	
1-99 gals.	8.7
100 gals. & over	7.7
Milwaukee	
1-99 gals.	9.0
100 gals. & over	8.0
Minneapolis	
1-99 gals.	9.1
100 gals. & over	8.1
St. Louis	
1-99 gals.	8.4
100 gals. & over	7.4
Kansas City	
1-99 gals.	8.1
100 gals. & over	7.1

*Taxes: In gasoline tax column are included these city taxes—Kansas City, St. Joseph and St. Louis, 1c. Iowa kerosine prices are ex 3c state tax. In naphtha tax column are included 1.5c federal tax and state taxes.

State sales, occupation, consumer and use taxes to be added when applicable.

HUMBLE OIL

Humble Motor Fuel (*Regular Grade*) Thriftane (*Third Grade*)

	Humble *Tank Wagon	Humble Re-tail	Thriftane *Tank Wagon	Thriftane Re-tail	Gaso-line Taxes
Dallas, Tex.	7.5	10.5	6.5	10.5	5.5
Ft. Worth, Tex.	6.5	9.5	6	7.5	5.5
Houston, Tex.	8.5	12.5	7.5	10.5	5.5
San Ant., Tex.	8.5	12.5	7.5	10.5	5.5

Kerosine

	*Tank Wagon	Retail
Dallas, Tex.	7	10
Ft. Worth, Tex.	7	11
Houston, Tex.	8	11
San Antonio, Tex.	7	10

73 Oct. Aviation Gasoline	Tank Car
FOB Baytown, Tex.	8.5

*To all classes of dealers & consumers.

Fuel oils—Statewide prices are for t.w. & drum deliveries of 50 gals. or more; prices for deliveries of less than 50 gals. are 0.5c higher. Cleveland Division assumed the state-wide fuel oil tank wagon prices on Nos. 1, 2 and 3 fuel oil, effective May 10. However the price of 7.55c per gallon and No. 4 fuel oil (full compartment hose dumps only) will remain as heretofore, in Cleveland Division.

Naphthas—to contract consumers off t.w. prices—Statewide: 300 to 999 gals., 0.5c; 1000 to 2499 gals., 0.75c; 2500 to 4999 gals., 1c; 5000 or more gals., 1.5c. Lucas County: Less than 50 gals., tank wagon price. 50 to 249 gals., 0.5c; 250 to 499 gals., 1c; 500 gals. or over, 1.5c.

S. O. OHIO

*Sohio X-70 Gasoline (*Regular Grade*)

	Con-sumer T.W.	**Re-sellers	‡S.S. Taxes	Gaso-line Taxes	†Kero-sine T.W.
Ohio, Statewide	12	10	13.5	5.5	9.3
Akron	12	9.5	12.5	5.5	9.3
Cincinnati	12	9.5	12.5	5.5	9.3
Cleveland	12	9.5	12.5	5.5	9.3
Columbus	12	9.5	12.5	5.5	9.3
Dayton	12	9.5	12.5	5.5	9.3
Marietta	12	9.5	12.5	5.5	9.3
Portsmouth	12	9.5	12.5	5.5	9.3
Toledo	12	9.5	12.5	5.5	9.3
Youngstown	12	9.5	12.5	5.5	9.3

Aviation Gasoline—Statewide

	Consumer T.W.	Gasoline Taxes
Sohio Aviation Gasoline clear Spec. AN-F-22	14.5	5.5
Esso Ethyl Aviation 73 Oct.	15.5	5.5
Esso Ethyl Aviation 80 Oct.	16.5	5.5
Esso Ethyl Aviation 87 Oct.	17.5	5.5
Esso Ethyl Aviation 91 Oct.	17.5	5.5
Esso Ethyl Aviation 100 Oct.	25.5	5.5

†Naphtha—T.W.

	Statewide	Lucas County
S. R. Solvent	13.5	13.5
D. C. Naphtha	14.5	14.25
V.M.&P. Naphtha	14.5	14.25
Varnolene	14.5	14.25
Sohio Solvent	14.5	14.25

Fuel Oils—T.W.	No. 1	No. 2	No. 3	No. 4
Ohio, Statewide	8.3	8.3	7.8	7.55*

*Renown (third-grade) prices are same as X-70 unless otherwise noted.

**Except authorized agents.

†Kerosine prices are ex 1c state tax. Naphtha prices are ex 1.5c federal & 4c state tax.

‡Prices at company-operated stations.

††Statewide prices are subject to exceptions other than those shown.

Discounts:

Esso aviation—on contract to hangar operators and resellers, 2c off consumer t.w.

*For Cleveland area only.

Canada

PRICES OF IMPERIAL OIL, LTD.

Per Imperial Gallon, which is 1.2 U. S. Gallons

IMPERIAL OIL

3-Star Imperial Gasoline (*Regular Grade*)

	†Gasoline T.W.	*Gasoline Taxes	†Kero-sine T.W.
Hamilton, Ont.	17.5	11	18
Toronto, Ont.	17.5	11	18
Brandon, Man.	21	10	23
Winnipeg, Man.	20.5	10	22.5
Regina, Sask.	18	10	20
Saskatoon, Sask.	20.8	10	22.8
Edmonton, Alta.	18.9	10	20.9
Calgary, Alta.	16	10	18
Vancouver, B. C.	15	10	24
Montreal, Que.	17	11	17.5
St. John, N. B.	16.5	13	19
Halifax, N. S.	16.5	13	19

*Includes 3c Federal, and Provincial taxes. To divided & undivided dealers.

ATLANTIC REFINING

Atlantic White Flash (*Regular Grade*)

	Commercial T.W.	Dealer T.W.	Gaso-line Taxes	Kero-sine T.W.
Philadelphia, Pa.	10.2	10.7	5.5	12.25
Pittsburgh	10.7	11.2	5.5	12.6
Allentown	10.7	11.2	5.5	12.6
Erie	10.7	11.2	5.5	12.6
Scranton	10.7	11.2	5.5	12.6
Altoona	10.7	11.2	5.5	12.6
Emporium	10.7	11.2	5.5	12.6
Indiana	10.7	11.2	5.5	12.6
Uniontown	10.7	11.2	5.5	12.6
Harrisburg	10.7	11.2	5.5	12.6
Williamsport	10.7	11.2	5.5	12.6
Dover, Del.	....	11.2	5.5	12.6
Wilmington, Del.	....	10.7	5.5	12.1
Boston, Mass.	....	10.9	5.5	....
Springfield, Mass.	....	11.8	4.5	....
Worcester, Mass.	....	11.5	4.5	....
Fall River, Mass.	....	11	4.5	....
Hartford, Conn.	....	11.6	4.5	....
New Haven, Conn.	....	11	4.5	....
Providence, R. I.	....	11	4.5	....
Atlantic City, N. J	....	10.7	4.5	10
Camden, N. J.	....	10.7	4.5	10
Trenton, N. J.	....	10.7	4.5	10
Annapolis, Md.	....	11 05	5.5	10.8
Baltimore, Md.	....	10.45	5.5	9.8
Hagerstown, Md.	....	11.55	5.5	10.3
Richmond, Va.	....	11.25	6.5	12.3
Wilmington, N. C.	....	11.55	7.5	11.9
Brunswick, Ga.	....	10.4	7.5	11.1
Jacksonville, Fla.	....	10.4	8.5	12.1

	Mineral Spirits T.W.†	V.M.&P. T.W.†
Philadelphia, Pa.	11	12.5
Lancaster, Pa.	12	13.5
Pittsburgh, Pa.	12.5	13.5

Fuel Oils—T.W.

	1	2	3	5	6
Phila., Pa.	10.1	9	9	5.76	5.04*
Allentown, Pa.	10 6	9.3	9.3	....	....
Wilmington, Del.	10.1	9	9	....	....
Springfield, Mass.	10.2	9.4	9.4	....	....
Worcester, Mass.	10.2	9.3	9.3	....	....
Hartford, Conn.	10.5	9	9	....	....

‡Does not include 1c Georgia kerosine tax.

†Mineral Spirits prices also apply to Stoddard Solvent; V.M.&P. prices also apply to Light Cleaners Naphtha.

Discounts:

Gasoline—to undivided dealers, 0.5c off dealer t.w., except Georgia & Florida dealer t.w. and undivided dealer t.w. prices are same.

Kerosine—Thru Penna. & Delaware, 2c off t.w. price on t.w. deliveries of 25 gals. or more at one time.

*Residual fuel 13.0-15.9 gravity effective 10/17/43.

S. O. KY.

Crown Gasoline (*Regular*) Standard (*Third Grade*)

	†Net Crown Standard	Dealer T.W.	Gaso-line Taxes	Kero-sine T.W.
Covington, Ky.	9.5	...	6.5	9.3
Lexington, Ky.	10.5	...	6.5	9.3
Louisville, Ky.	10	...	6.5	8.8
Paducah, Ky.	10	...	6.5	8.8
Jackson, Miss.	10	...	7.5	*9
Vicksburg, Miss.	9.5	...	7.5	*8.5
Birmingham, Ala.	10	...	*8.5	9
Mobile, Ala.	9	...	*9.5	9.5
Montgomery, Ala.	10	...	*9.5	10
Atlanta, Ga.	11.4	...	7.5	*12.1
Augusta, Ga.	11.4	...	7.5	*11.6
Macon, Ga.	11.4	...	7.5	12.1
Savannah, Ga.	10.4	...	7.5	11.1
Jacksonville, Fla.	10.4	...	8.5	10.1
Miami, Fla.	10.4	...	8.5	10.1
Pensacola, Fla.	9	8	*9.5	8
Tampa, Fla.	10.4	...	8.5	10.1

*Taxes: In tax column are included these city and county gasoline taxes: Mobile, 2c city; Birmingham, 1c city; Montgomery, 1c city and 1c county; Pensacola, 1c city. Georgia and Montgomery, Ala. have 1c kerosine tax, Mississippi 0.5c, not included in above prices.

†Consumer t.w. prices are same as net dealer prices.

S. O. LA.

Esso Gasoline (*Regular Grade*)

	Consumer Tank Wagon	Dealer T.W.	Gaso-line Taxes	Kero-sine T.W.
New Orleans, La.	8.75	9.25	8.5	*9
Baton Rouge, La.	8.75	9.25	8.5	*9.5
Alexandria, La.	8.75	9.25	8.5	*9.5
Lafayette, La.	9	9 5	8.5	*9
Lake Charles, La.	9	9.5	8.5	*11
Shreveport, La.	8.5	9	8.5	*8
Knoxville, Tenn.	10.5	11	8.5	12.5
Memphis, Tenn.	8.90	9.40	8.5	10.5
Chattanooga, Tenn.	10.5	11	8.5	11
Nashville, Tenn.	10.5	11	8.5	10
Bristol, Tenn.	10.95	11.45	8.5	13.1
Little, Rock, Ark.	9.5	10	8	10

*Louisiana kerosine prices are ex 1c state tax.

Discounts:

Esso Gasoline—To undivided dealers, 0.5c off dealer t.w.

(Continued on next page)

Atlantic Coast (Prices are of refiners, FOB their refineries & their tanker terminals, & of tanker terminal operators FOB their terminals)—Prices in Effect Feb. 28

MOTOR GASOLINE

District	72 Oct. (ASTM)	68-70 Oct. (ASTM)
N. Y. Harb.	9.2 - 9.4	9.2 (1)
N. Y. Harb., barges	9.1 - 9.3	9.1 (1)
Albany	9.3 - 9.5	....
Philadelphia	9.2	....
Baltimore	8.95	8.85 (1)
Norfolk	8.7 - 8.95	8.5 (1)
Wilmington, N. C.	8.7 - 8.75	8.5 (1)
Charleston	8.7 - 8.8	8.1 (1)
Savannah	8.25 - 8.4	....
Jacksonville	8.27 - 8.4	....
Miami	8.27 (1)	....
Tampa	8.27 - 8.4	8.275 (1)
Pensacola	7 - 7.2 (1)	....
Mobile	7 - 7.2	....
New Orleans	6.125- 6.75	....
Portland	9.5 - 9.65	....
Boston	9.4 - 9.7	9.7 (1)
Providence	9.4 - 9.7	....

FUEL OILS

District	KEROSINE and/or NO. 1 FUEL	No. 2	No. 3	No. 5	No. 6
N. Y. Harb.	7.1	6.7	6.7	$1.95-$2.01 (a)	$1.65 -$2.07
N. Y. Harb., barges	7	6.6	6.6	....	....
Albany	7.3	6.8	6.8 (2)	....	$1.85-$2.27 (1)
Philadelphia	7.2	6.7	6.7	$1.98	$1.65 -$2.07
Baltimore	7.2	6.7	6.7	....	$1.65 -$2.07
Norfolk	7.1	6.7	6.7 (1)	....	$1.65-$2.07 (2)
Wilmington, N. C.	7.05	6.7	....	....	....
Charleston	7.2	6.7 (2)	....	....	$1.60-$2.02 (2)
Savannah	7.05	....	....	....	$1.60-$2.02 (1)
Jacksonville	7.05 (2)	6.25	....	....	$1.60-$2.02 (1)
Miami	7.05 (2)	....	....	....	....
Tampa	7.05	6.25 (2)	....	....	$1.50-$1.92 (2)
Pensacola	4.8 (1)	....	....	....	....
Mobile	4.75 (2)	....	....	....	....
New Orleans	4.25 - 4.75	3.75 (2)	....	$1.27 (1)	$0.85-$1.27 (2)
Portland	7.3	6.8	6.8 (2)	....	$1.65-$2.07 (1)
Boston	7.2	6.7	6.7 (2)	$1.95-$2.07 (1)	$1.65 -$2.07
Providence	7.2	6.7	6.7 (2)	$1.90 (1)	$1.65 -$2.07

(a) This price is for a straight-run low pour test No. 5 fuel.

Tank Wagon Prices (Continued)

SOCONY VACUUM

	Socony Mobilgas (Regular Grade) Com. Cons. T.W.	Indiv. Dlr. T.W.	Gasoline Taxes
New York City			
Manhattan & Bronx	10.1	10.6	*5.5
Kings & Queens	10.1	10.6	*5.5
Richmond	9.7	10.2	*5.5
Albany, N. Y.	9.9	10.4	5.5
Binghamton, N. Y.	11	11.5	5.5
Buffalo	10.2	10.7	5.5
Jamestown, N. Y.	10.4	10.9	5.5
Mt. Vernon, N. Y.	10.1	10.6	5.5
Plattsburg, N. Y.	11	11.5	5.5
Rochester, N. Y.	10.8	11.3	5.5
Syracuse, N. Y.	10.5	11	4.5
Bridgeport, Conn.	10	10.5	4.5
Danbury, Conn.	10.5	11	4.5
Hartford, Conn.	10.6	11.1	4.5
New Haven, Conn.	10	10.5	4.5
Bangor, Me.	10.7	11.2	5.5
Portland, Me.	10.3	10.8	5.5
Boston, Mass.	9.9	10.4	4.5
Concord, N. H.	11.4	11.9	5.5
Lancaster, N. H.	12	12.5	5.5
Manchester, N. H.	11.3	11.8	5.5
Providence, R. I.	10	10.5	4.5
Burlington, Vt.	10.9	11.4	5.5
Rutland, Vt.	11	11.5	5.5

	Mineral Spirits T.W.	V.M.&P. T.W.
Buffalo, N. Y.	12.4	13.6
New York City	11	12
Rochester, N. Y.	13.2	14.4
Syracuse, N. Y.	14	....
Boston, Mass.	12	13
Bridgeport, Conn.	†16.3	†17.3
Hartford, Conn.	†16.3	†17.3
Providence, R. I.	13	14

	Kerosine Yard	Kerosine T.W.	Mobilfuel Diesel T.C.	Mobilfuel Diesel T.W.	Mobilheat Fuel Yard	Mobilheat Fuel T.W.
New York:						
Manhat'n & Bronx	7.5	10.3	...	9.3	7.1	9
Kings & Queens	7.5	10.3	...	9.3	7.1	9
Richmond	7.5	10.3	...	...	7.1	9.0
Albany	7.5	9.8	7	9.3	7	9
Binghamton	8.9	11.2	...	10.7	8.4	10.2
Buffalo	8.6	10.9	8	10.3	8.2	10
Jamestown	8.7	11	...	10.6	8.3	10
Mt. Vernon	7.6	10.3	...	9.4	7.2	9
Plattsburg	8.1	10.4	...	9.9	7.6	9.4
Rochester	8.7	11	7.9	10.2	7.9	9.7
Syracuse	8.5	10.8	7.8	10.1	7.8	9.6
Conn.:						
Bridgeport	7.8	10.3	...	....	7.2	8.8
Danbury	8.2	10.8	...	....	7.5	8.8
Hartford	8 0	10.5	...	9.5	7.2	9
New Haven	7.8	10.3	...	9.3	7	8.9
Maine:						
Bangor	7.9	10.2	7.4	9.7	7 4	9.1
Portland	7.5	10.2	7	9.3	7	9
Mass.:						
Boston	7.8	10.6	6.9	9.2	7.1	9
N. H.:						
Concord	8.4	10.7	...	....	8.2	10
Lancaster	9.5	11.8	...	....	9.2	11
Manchester	8.5	11.1	...	....	7.9	9.7
R. I.:						
Providence	7.6	9.9	6.9	9.2	7.1	8.9
Vermont:						
Burlington	8.1	10.4	7.5	9.8	7.5	9.2
Rutland	8.3	10.6	...	10	7.7	9.5

*Does not include 1% city sales tax applicable to price of gasoline (ex tax).

†In steel barrels.

Discounts: Diesel—On t.w. deliveries, 0.5c for at least 400 gals.; 1c for full tank truck.

	Bunker C Fuel Ships' bunkers (Ex Lighterage)	Diesel Oil Ships' bunkers (Ex Lighterage)	Diesel Oil Shore Plants	Gas House Gas Oil 28-34 Gravity
N. Y. Harbor	$1.65-$2.07	$2.78	6.7-6.8 (2)	6.8 (2)
Albany	$1.85 (1)	$2.98 (1)	7 (1)	6.7
Philadelphia	$1.65-$2.07	$2.78	....	....
Baltimore	$1.65-$1.89	$2.78	6.7 (1)	6.7 (1)
Norfolk	$1.65-$2.07	$2.78	6.7 1)	6.7 (1)
Charleston	$1.60-$2.02	$2.78 (2)	6.7 1)	6.7 (1)
Savannah	$1.65-$1.89	$2.62 (1)	....	....
Jacksonville	$1.60-$2.02 (2)	$2.62 (2)	....	....
Tampa	$1.50-$1.92	$2.62 (2)	....	....
New Orleans	$0.97-$1.09	$1.65 (1)	4 (1)	....
Portland	$1.65-$1.89	$2.86 (2)	7 (1)	6.9 (1)
Boston	$1.65-$1.89	$2.78	6.7 (2)	6.8 (2)
Providence	$1.65-$2.07	$2.78 (2)	6.9 (1)	6.8 (1)

Residual fuel prices generally vary with A.P.I. specifications from range low for 9.9 & below degrees to range high for 25.0 & above.

Pacific Export *In Ship's Bunkers, or deep tank lots:*

Prices in Effect	Feb. 28	Feb. 21
Diesel Fuel, Pac. Spec. 200	$1.45	$1.45
Grade C fuel, Pac. Spec. 400	$1.10	$1.10

Seaboard Export Coastwise Prices

Gulf Coast

Prices in Effect Feb. 28

MOTOR GASOLINE	New Orleans & Lower Mississippi to Baton Rouge Tank Cars	New Orleans & Lower Mississippi to Baton Rouge Barge	Texas Gulf Coast South of New Orleans Tank Cars	Texas Gulf Coast South of New Orleans Barges	CARGOES Domestic & Export From all Gulf Ports
Leaded (oct by ASTM)					
76 oct.	6.75	6.5 - 6.75	6.75	6.75	6.75
72 oct.	6.125	5.75	5.75	5.75	5.75
63-65 oct.	....	....	....	....	....
Unleaded 70 oct.	....	....	....	....	5.75
67-68 oct.	....	....	....	....	5.5
65 oct.	....	....	....	....	5.25
60 oct.	....	....	....	....	5
KEROSINE & LIGHT FUELS					
41-43 w.w. kero.	4.125-4.25	4.125	4.125-4.25	4.125	4.125
42-44 w.w. kero.	....	....	4.125	4.125	4.125
No. 2 fuel oil	3.75	3.75	3.75 - 4	3.75	3.75
DIESEL & GAS OILS					
(In diesel index No.)					
Below 43 di.	....	....	....	....	....
43-47 di.	....	....	....	....	4
48-52 di.	4	4	4	4	4
53-57 di.	4.125	4.125	4.125	4.125	4.125
58 and above	4.25	4.25	4.25	....	4.25

HEAVY FUELS & BUNKER OILS In Cargoes (At all Gulf Ports) Heavy Diesels	In Ship's Bunkers (Ex lighterage)
Below 28 API Grav.	$1 35
28 & above API Grav.	$1.65
Bunker C Oil	$0.85-$1.27

Above products in Truck Transports of 2,400 gal. and over ½c above Tank Car Prices.

NOTE—Prices for heavy fuels vary within the range given above according to gravity from 9.9 B grav. and below to 25 B and above.

Mid-Continent Lubes

(At Gulf; in packages, FAS.; in bulk, FOB terminals)

Prices in Effect Feb. 28

	Steel Drums	Bulk
200 Vis. D 210 brt. stock	35 (1)	28.8 (1)
150 vis. D 210 brt. stock 0-10 p.p.	31 (1)	24.8 (1)
10-25 p.p.	....	....
100 vis. D 210 brt. stock 0-10 p.p.	....	....
10-25 p.p.	....	....
200 vis. No. 3 col. neutral: 0-10 p.p.	....	....

Wax

(Melting points are AMP, 3° higher than EMP. Prices are FOB refinery and do not include bag, freight or export differentials).

Prices In Effect Feb. 28

Crude Scale	New Orleans Export	N. Y. Domestic	N. Y. Export
124-6 Yellow	4.25(1)	....	4.25(1)
122-4 White.	....	4.25(2)	4.25(2)
124-6 White.	4.25(1)	4.25	4.25
Fully Refined:			
123-5	5.2(1)	5.2(2)	5.2(1)
125-7	5.2(1)	5.2(2)	5.2(1)
128-30	5.6(1)	5.6	5.6(1)
130-32	5.85(1)	5.85(2)	5.85(1)
133-5	6.15(1)	6.15	6.15(1)
135-7	6.4(1)	6.4(1)	6.4(1)

Naphtha

Prices In Effect Feb. 28

	V.M.&P. Naphtha	Mineral Spirits
New York Harbor	11 (2)	10
Philadelphia dist.	11 (2)	10
Baltimore	10.5 (2)	9.5
Boston	11.5 (2)	10.5
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1940 Ford Tractor and 3400-gallon Semi-Trailer with pump. Both in good condition and with from new to good rubber. Write P. O. Box 598, Evansville, Indiana, or phone 8391.

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1—Viking Pump single unit 2½" Suc & Dis-3-HP Single phase 110-220-V Motor excellent condition—$150.00.

1—Turn Blackmer Pump Unit 2" Suc & Dis with relief valves and clutches 5 HP Motor 3 phase 110-220 V Motor—Good condition—$175.00.

2—20,000 gallon Horizontal Storage Tanks $750.00 each.

John T. McIntee

1028 Chili Ave. Rochester, N. Y.

Situations Open

REFINER needs man for Middle West familiar with use and application of sulphonates, rust preventives, soluble cutting oil bases, petrolatums and Pennsylvania Oils. State draft status, age and experience. Box 277, National Petroleum News, 59 E. Van Buren Street, Chicago 5, Ill.

REFINERY CHEMISTS

Refinery analytical chemists and low and high temperature fractional operators wanted for work in 100 octane plant. W.M.C. Certificate necessary. Write Personnel Manager,

Associated Refineries, Inc.,
Duncan, Oklahoma

WANTED

Chemist for laboratory familiar with manufacture of White Oils, Petroleum Sulfonates and related products, by old established company, chance for advancement. State age, experience, schooling, salary and draft status.

Box No. 346

PROCESS ENGINEERS

Two Process Engineers also two Junior Process Engineers. Must have chemical, mechanical or petroleum engineering degree. W.M.C. Certificate necessary. Write

Associated Refineries, Inc.,
Box 831 Duncan, Oklahoma

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Experienced in both operations and maintenance. Graduate engineer 35 to 50 years of age who has a good record as a practical operating man, administrator and handler of men.

Successful independent oil company with completely integrated operations located in Ohio valley.

Reply Box No. 347

Wanted to Buy

4200 to 4500 gallon three compartment trailer. Advise price and all other information. Southern Oil Company of N. Y., Inc., Horseheads, N. Y. Phone 61.

WANTED: Neptune Meter with 1" connections and Air Eliminator. Keenan Oil & Fuel Co., 1753 Eastern Ave., Cincinnati, Ohio.

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Midwest Oil Jobber wants complete line oils, compounds and coolants to market under own brand. Must be proven products with technical information available.

Box No. 345
National Petroleum News

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• • • • WANTED • • • •

Major oil company with continent-wide operations and research seeks graduate technical men of the following qualifications:

MECHANICAL ENGINEERS—with petroleum refinery or similar experience. Should be familiar with refinery design, estimating, construction, mechanical equipment, engineering materials, and utilities systems. Process knowledge desired although not essential.

CHEMISTS AND CHEMICAL ENGINEERS interested in research, design, or plant operation. Should have training and experience in refinery or other industrial organizations.

Work not of a temporary nature. In reply state experience, education, age, marital status, draft classification and salary expected, include small snapshot (not returnable). Replies strictly confidential. Applicants now employed at highest skill in war industries not solicited. Box No. 249, National Petroleum News, Cleveland, Ohio.

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ABOUT OIL PEOPLE

Mr. Koechling

H. A. Koechling, assistant comptroller of the Standard Oil Co. of New Jersey, has been named comptroller of the company and also a member of the board of directors. He replaces **Walter Schaefer** who resigned to devote all of his time to his job as assistant comptroller of the Standard Oil Co. (N. J.) a post he held simultaneously with the one he resigned. Mr. Koechling has been with Standard Oil Co. of New Jersey since 1917.

° ° °

Bud Vardaman, service engineer, railway sales dept., Standard Oil Co. (Indiana) recently shipped home to Chicago from Jackson Hole, Wyo., a quantity of meat equivalent to 10,000 meat ration points, along with enough trout and white fish to vary the menu for family and friends for several weeks. During his hunting trip, this mighty "Deadeye Dick" brought down a moose, an elk and a bear. And for his doubting Thomas friends he sent photographic proof, including a picture of the antlers from the elk measuring 48 inches from tip to tip, and proof that the big black bear tipped the scales at 400 pounds.

° ° °

John Sterritt, production superintendent for Skelly Oil Co., has been transferred from Carmi, Ill., to Tyler, Texas.

° ° °

Joe Wheeler has been named district geologist for Stanolind Oil & Gas Co. at Jackson, Miss.

° ° °

Championship of the Humble Club Men's golf tournament, held recently, went to **B. W. January,** who was awarded a sports jacket and three golf balls for his low net of 63. Runners-up were **Bill Crossland,** with a 67 and **George Standish,** with a 68.

° ° °

E. W. Neason has been named treasurer of the South Shore Oil and Development Co., Houma, La., succeeding M. Q. Petersen who has resigned as vice-president and treasurer. Mr. Neason's headquarters will be in New York. **Andrew Milek,** chief petroleum engineer for the company, will be in charge of the company's new offices which have been transferred from New Orleans.

° ° °

Harold D. Ward has returned to the Houston office of Humble Oil & Refining Co. as industrial relations manager. He has been regional industrial manager of the company's Southwest Texas division in Corpus Christi since 1938.

The retirement of **M. J. McLaughlin** as vice-president and manager of production for Magnolia Petroleum Co. has been announced by **D. A. Little,** Magnolia president. Mr. McLaughlin has been succeeded by **E. D. Smith,** who started with Magnolia in 1918 as foreman in the Augusta, Kans., production district. Before that, he had been associated with South Penn Oil Co. Since March, 1939, Mr. Smith has been assistant manager of the producing department.

Mr. McLaughlin's retirement brought to an end a career of more than 45 years in the petroleum industry. His first oil job was with South Penn, in 1898. He became associated with Magnolia in 1912 and held various posts in the company before his election as vice-president.

° ° °

Jack Gately, sales manager of the New York division of Cities Service Oil Co., was recently honored at a dinner attended by employes and executives of the company. **E. C. Mackey,** superintendent of operations in the New York division, acted as toastmaster.

° ° °

Frank S. Kelly, Jr., industrial engineer for the Arkansas-Louisiana Gas Co., was recently installed as president of the Shreveport Goodwill Industries, a Community Chest agency. He will hold the post for one year.

° ° °

At a recent meeting of the Mid-Continent Oil and Gas Assn., **H. W. Pryor,** of the Arkansas Natural Companies tax and insurance department, was named vice-chairman of the association's steering committee on state and local taxation, for the Louisiana-Arkansas division.

° ° °

Selection as one of the five outstanding young men in the state of Texas is the honor won by **James E. Oliver,** chief clerk of proration contamination statistics for the Humble Pipe Line Co. Selection was made by the Texas Junior Chamber of Commerce and was based on outstanding community service and Jaycee work. Mr. Oliver is now president of the Texas Junior C. of C., and a former vice-president of the Houston Junior Chamber. Last year he was chosen as one of the 10 outstanding Jaycee men in the nation.

° ° °

Charles J. Hoffman, veteran land scout who has been with the Southland Royalty Co. in Fort Worth since its organization in 1926, has resigned as head of the land department, effective April 1, to go in business for himself. He has been connected with the Yarhola Pipeline Co., and the Oklahoma Central Oil Co. In World War I he was awarded a Purple Heart for an injury received in the St. Mihiel drive.

Directors of Standard Oil Co. (Indiana) have elected **H. E. Hanson,** senior assistant general manager of sales, to board membership. Mr. Hanson will continue as assistant general sales manager. He has been with Standard since 1909, joining the company as a clerk and stenographer.

° ° °

Two oil men saw an oil well for the first time recently when **Hugh Harper,** manager of the process plant division of Head, Wrightson & Co., Ltd., London, and **S. T. Robson,** chairman of the Council of British Manufacturers of Petroleum Equipment, visited Oklahoma. They were guests of Paul S. Hedrick, oil editor of *The Tulsa World*. Head, Wrightson & Co., Ltd., has constructed refineries in Iraq.

° ° °

W. R. Brison, general supervisor of lubricating oils and processing units of Humble Oil & Refg. Co., has retired from active service after 21 years with Humble and 40 years in the oil industry. Mr. Brison joined Humble in 1922 when he reorganized and expanded the laboratory at Baytown refinery and headed that division until 1930, when he was transferred to the Houston office as consulting assistant to the executive refinery management group. A year later he returned to the position he held at the time of his retirement.

° ° °

Clarence A. Wiggins, and **George I. McFerron,** former president and vice president, respectively, of the Adams Oil and Gas Co., have formed a partnership under the name of Wiggins and McFerron Oil Co. and will maintain offices in Houston.

° ° °

Mr. Morgan

Thomas A. Morgan, president and director of the Sperry Corp., was recently elected a director of the Shell Union Oil Co. at a meeting of the board. Announcement was made by **R. G. A. van der Woude,** Shell Union president.

Mr. Morgan is a director and chairman of the executive committee of Pan American Airways Corp. and chairman of the board of directors of the Sperry Gyroscope Co., Inc. He is also a member of the board of governors of the Aeronautical Chamber of Commerce of the U. S., a director of the National Foreign Trade Council, Inc., and the American Arbitration Assn.

E. F. Jones, formerly superintendent of the Derby refinery, is now a Lieutenant in the Navy. His last base was on an island southwest of Honolulu, where his skill as a lubrication engineer is being put to good use.

° ° °

Maj. Hugh Lowery, on leave of absence from the research dept. at the Wood River refinery of Standard Oil Co. (Indiana) is now overseas with the army. Maj. Lowery was an aviation instructor with the A. E. F. in France during World War I. Until recently he was commanding officer at Kirtland Field Army base near Albuquerque, N. M.

° ° °

Staff Sergeant George E. Powell, formerly an inspection tester in Shell Oil Co.'s control laboratory at Wood River refinery, was recently awarded the Distinguished Flying Cross for heroism. Sgt. Powell is a tail gunner on a bomber and has been in service for almost two years. He has previously been awarded the Airman's Medal and three Oak Leaf Clusters.

° ° °

Commander George M. Dixon, formerly sales agent for Tide Water Associated Oil Co. at San Francisco and pilot of the Associated plane, "Motormates", has been made commander of the U.S. Naval Air Station at Newfoundland.

° ° °

J. Henry Taylor, former co-pilot and mechanic in the Humble Oil & Refining Co.'s aviation department, has been promoted to the rank of Major. He is stationed with the 444th Bomber Squadron at Great Bend, Kans.

° ° °

Ensign Mary Evelyn Jordan, former employe of the geological department of Texaco's West Texas division, was among the SPAR officers recently commissioned at the Coast Guard Academy, New London, Conn. Ensign Jordan will go to Washington, D. C. for additional training.

° ° °

Col. Paul E. Keller, former commanding officer of the Fort Douglas hospital, has been named deputy service command surgeon and chief of the professional section of the Ninth Service Command. He was promoted to colonel on Jan. 3. Col. Keller, who has been in the regular army for several years, received his early business training working during summer vacations for NPN. His sister, Helen, is employed in NPN's advertising department.

C. W. Sanders, who has done consulting work in Houston, has gone with Danciger Oil and Refining Co. of Fort Worth as chief geologist. He replaces **Paul L. Applin,** who resigned to join the U. S. Geological Survey. Mr. Sanders was with Shell Oil Company, Inc., for 17 years, majority of the time in Europe, advising on the Shell group's activities in the U. S. and studying the salt domes of Germany and Rumania.

° ° °

New division manager at Midland, Tex., for Shell Oil Co., is **C. C. Roripaugh,** who has been with the company since 1927. For a year he worked as a roustabout at Long Beach, Cal., and then advanced to junior engineer. In 1932 he became field engineer and a year later a division engineer at Los Angeles. Since 1939 he has been division superintendent of the Texas-Gulf area.

From an oil secretary in Tulsa comes the following letter:

"Yesterday I received my lovely box of candy from you and your staff. To merely say 'thank you' is too small a thing to express my thanks. But I do want you to know of my appreciation and continued support of your column. It makes us feel that we have a part, too, in the 'oily news' of your magazine".

Thanks. All it takes to get a box, or a carton of cigarets for your friend in the service, girls, is to send an acceptable lazybench item.

Address Lazybench Editor, 5th Floor, Penton Bldg., Cleveland 13, Ohio.

With **Edwin J. Freeman** of Acme Petroleum Co. in Chicago as the grandfather and **G. E. Gustafson** of Gustafson Brothers, Chicago, as a very interested observer, **Donna Joan Roeber,** born Feb. 5, can't help but grow up into an oil woman. The mother, Joan Roeber, is the daughter of Mr. Freeman and formerly worked in Mr. Gustafson's office.

° ° °

John N. Mouser, district land man for the Midstates Petroleum Corp., who has had headquarters in Houston for several years, will move to Wichita Falls, Tex., to open offices for the company.

° ° °

Vernon E. Autry, geologist with the Fain-McGaha interests in Wichita Falls, Tex., for the past 10 years, has moved to Dallas to become associated with **M. M. Garrett.**

° ° °

J. C. Hinds, formerly with Southport Petroleum Co. at Texas City, Texas, has been named superintendent of Danciger Oil & Refg. Co.'s refinery at Longview which will start running again about March 15, after being shut down since 1938.

LAZYBENCH

R's Do

'A' car came in the driveway,
And I looked out to 'C'
A little miss behind the wheel,
As cute as she could 'B'.
She said, "Please fill 'er up".
Said I, "I'll be 'D'-lighted
If you have got your ration book,
Everything will soon be righted."
She handed me the coupons
And drove away with 'E's',
She left me standing by the pump,
Holding a couple of 'T's'.

A carton of cigarets coming up for a G.I. Corporal because an Irving, N. Y. "oil lady" took time to send the above.

° ° °

The Ohio Gas & Oil Assn. bulletin nominates this as the prize OPA story of 1943:

The telephone rang in the district OPA office in Pittsburgh and the caller inquired: "I want to know the price ceiling on "C" gasoline coupons. I've been offered some at 8c a coupon and some at 10c, but I don't want to help violate the law by paying more than the ceiling price."

° ° °

A certain service station attendant who had worn a truss for 12 years was called up for his physical examination to determine his fitness for the army. The doctor, after looking him over asked him how long he had worn the truss. The attendant told him he had worn it 12 years. He was placed in 4-F.

On his return to work he told a buddy about the incident. So his fellow worker asked him if he could wear his truss when he went for his examination. When he was examined the doctor asked him how long he had worn a truss and he told him 12 years. The doctor said—"O.K.—we will put you in 6-E". This was quite puzzling. He asked the doctor what it meant.

"In six weeks you will be in Egypt. Anyone who can wear a truss upside down for twelve years can surely ride a camel," replied the doctor.

Miss Leona Rogers, Secretary with the Spencer Gas & Oil Co., Spencer, Ohio, will receive her choice of candy for herself or cigarets for a friend in the service for this Lazybencher.

° ° °

Officer. (to oil man in bar): "I think you're drunk."

Oil man: "Oh no, I'm not. I've only had teen martoonies. I'm not so much under the alcofluence of incohol as some pipple stink, but the tighter I set here, the longer I get."

° ° °

And there was the optimist who married at 87 and started house hunting for a nice place close to a school.

—Breh Rolyat

YOUR NEXT BROWNIE TANK WILL HAVE GUTS...AND *Glamour* TOO!

CUSTOM-BUILT truck and trailer tanks to meet your specifications . . . special deluxe jobs or untrimmed tanks to suit any use. Our years of experience assure your satisfaction.

Though our production is restricted, our organization can assist in planning and developing new tanks for you. We can also supply a limited number of tanks for early delivery.

We solicit your inquiries now.

40 IMPROVED IDEAS FOR GREATER EFFICIENCY

From stem to stern your Brownie tank of tomorrow will have new technical features in addition to eye-catching exterior design . . . to assure new efficiency in transporting your fuel oil, gasoline and other petroleum products.

Typical benefits to be offered are:

EASIER OPERATION . . . through new facilities for delivery—improved reels, nozzles, etc.

GREATER ECONOMY... with perfect distribution of load, labor-saving devices, etc.

INCREASED SAFETY on the road with new Brown inverted safety vents. Very efficient.

IMPROVED SPEED in discharging, etc., to save time on calls. Full-flow valves.

BROWN STEEL TANK COMPANY

NOT AFFILIATED • ONE OFFICE, ONE PLANT • MINNEAPOLIS, MINNESOTA

Blend Oils That Fight Wea
. . . Protect Your Future Wit
SUN No. 96

Springtime is servicetime for millions of America's essential wartime trucks, cars and busses. And it's your war job to help stretch the miles in these essential units of transportation.

With Sun No. 96 (80/90 @ 210° F.) you can blend durable, low carbon lubricants in all SAE grades from 20 to 50 — lubricants high in wear protection, that will stand up and "take it" under today's toughest operating conditions. Check these advantages of Sun No. 96 — the heavy base golden stock — against your present blending stock:

- **LESS THAN 2/10 OF 1% CARBON CONTENT**
- **ENTIRELY FREE OF CORROSIVE ACIDITY**
- **HIGH IN LUBRICATING VALUE**
- **TOUGH AND LONG LASTING**

Meet today's service demands — and strengthen your reputation for future markets by tying up with the complete line of Sun lubricants. It includes everything from finished oils to blending oils and more than 60 greases and bases. Write today for complete information to

SUN OIL COMPANY • ***Philadelphia 3, Pa.***

Sun Oil Company, Ltd., Toronto, Canada

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TECHNOLOGY DEPT.

NATIONAL PETROLEUM NEWS

Monthly Technical Section Devoted to

REFINERY MANAGEMENT *and* PETROLEUM CHEMICAL TECHNOLOGY

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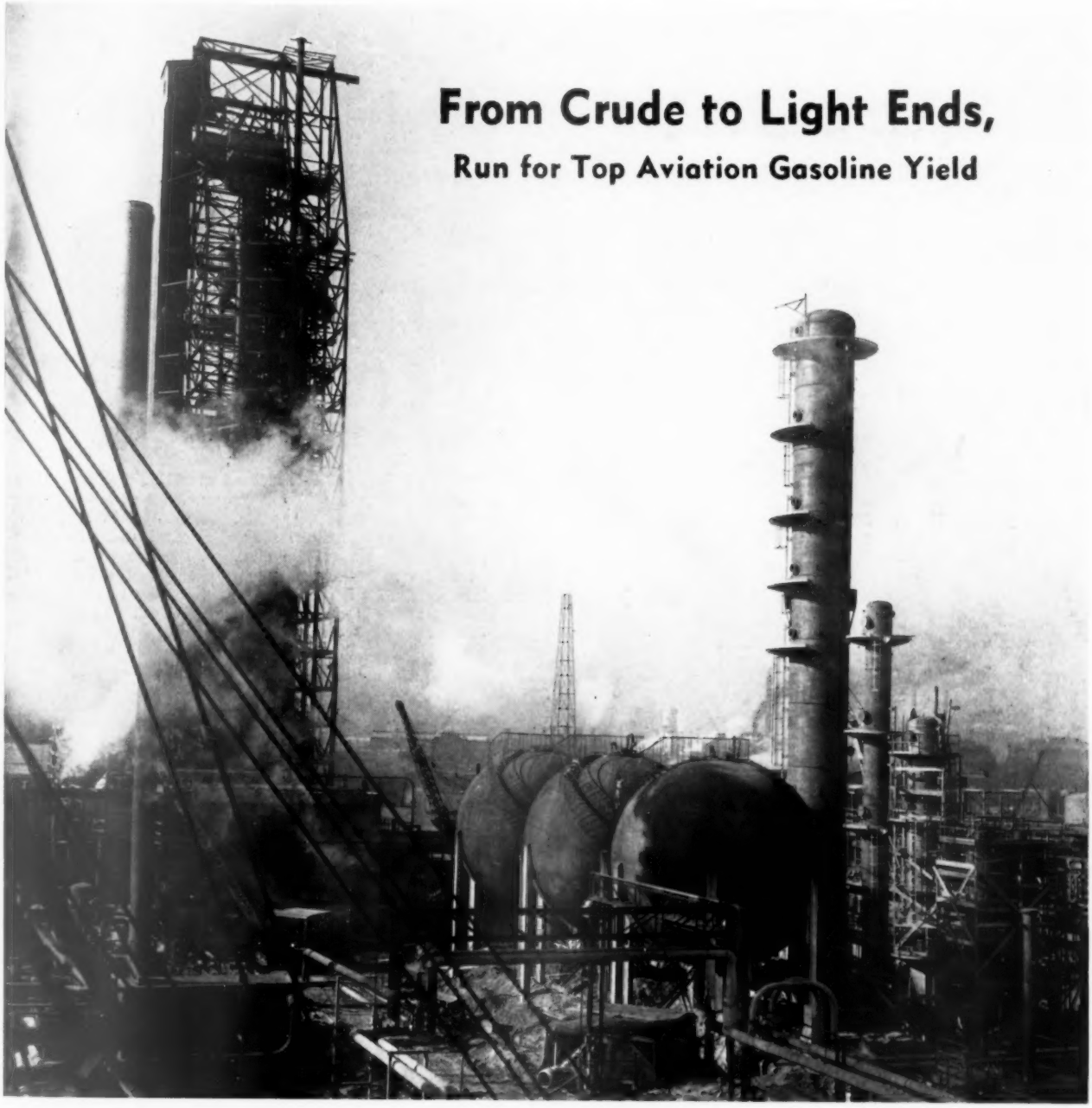
Section Two **March 1, 1944**

From Crude to Light Ends,

Run for Top Aviation Gasoline Yield



The East St. Louis refinery of Socony-Vacuum Oil Co. (Lubrite Division) is being transformed for the manufacture of 100-octane gasoline. A Thermofor Catalytic Cracking unit and HF alkylation unit are major installations nearing completion. The TCC plant (left) stands 235 feet high. The spheroids, approximately 30 feet in diameter, are for the butane-butylene charge for the HF plant and for isobutane feed and storage.

Large tower in right foreground is a de-isobutanizer, 115 feet high, with 50 trays. It prepares an isobutane cut which is part of the feed to the hydrofluoric acid contactors. Next tower is a debutanizer, 63 feet high, which stabilizes the alkylate cut. The third tower fractionates the light alkylate from a heavier cut. Lummus Co., New York, engineered the TCC unit, Fluor Corp., Los Angeles, the alkylation unit

Managers of a 100,000-Ton Petroleum Butadiene Plant, Run Jointly by 5 Oil Firms

Herbert Henderson

J. B. Rather

W. H. Hoffman

PRESIDENT of Neches Butane Products Co. butadiene plant at Port Neches, Texas, is W. H. Hoffman, whose services were made available by The Texas Co. He started in that company's research laboratory in 1919 after graduating in chemistry from Pennsylvania State College. He has been superintendent of its refineries in this country and abroad and just before accepting his present position was operating the Buenos Aires refinery owned jointly by The Texas Co. and Socony-Vacuum Oil Co.

CHAIRMAN OF THE BOARD of Neches Butane Products Co. and director representing Gulf Oil Corp. is Herbert Henderson, Pittsburgh, vice president of Gulf Oil, who for many years has supervised that company's construction programs. He went to Washington at the government's call to initiate the entire co-operative venture.

VICE PRESIDENT is J. B. Rather, New York, director of research for Socony-Vacuum Oil Co. Inc. and chairman of its refinery processes committee. He is a native of Texas, holds scientific degrees from Agricultural and Mechanical College of Texas and Johns Hopkins University, and first became connected with the petroleum industry in 1918 as assistant chief chemist of the Standard Oil Co. of New York. He has patented testing apparatus and refinery processes used by oil companies. For Neches' plant Dr. Rather is also a director representing Socony-Vacuum Oil Co.

REFINERY MANAGEMENT *and*
PETROLEUM CHEMICAL TECHNOLOGY

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Volume 36
Number 9

A MONTHLY TECHNICAL SECTION OF NATIONAL PETROLEUM NEWS *incorporating International Petroleum Technology*

High Yield of Petroleum Butadiene Is Provided in Port Neches Plant

Five large oil companies and a refinery construction firm pooled their technical knowledge and experience to build a plant in Texas which will supply one-fourth of the butadiene which is to come from petroleum derivatives, in the government's rubber program. The feed stocks are supplied from the nearby refineries of the oil companies.

One of the editors of the Technical Section of National Petroleum News visited the plant while it was still under construction to secure the first detailed account of the processes and methods used in this jointly operated butadiene-from-petroleum enterprise.

By D. P. Thornton, Jr.

BUILT AND OPERATED through oil industry and government cooperation . . . without profit . . . for the successful prosecution of the war . . . and a victorious peace.

This is the story of the Neches Butane Products Co. butadiene plant at Port Neches, Texas, which is being told the public in advertising and over the radio by the five oil companies which participated in this outstanding industrial achievement of the war.

On Feb. 23rd the formal public dedication of the plant took place with appropriate ceremonies, in the midst of huge towers and buildings, on grounds which 24 months ago had been just 314 acres of bare marsh lands along the Texas Gulf coast. Many notables in the oil industry and in government positions attended, as well as military officials.

Principal features of the Neches plant, as seen by this writer on a visit there a few weeks ago, when thousands of workers were still busy, included:

Enough butadiene will be turned out to supply one-eighth of the entire U.S. wartime production of synthetic rubber.

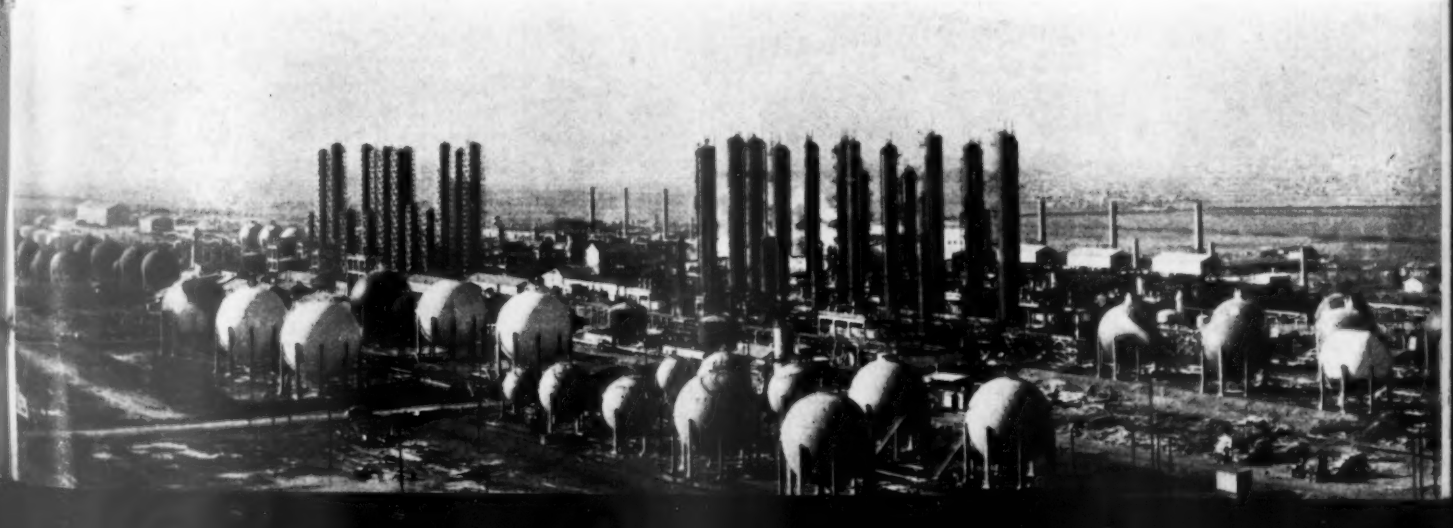
It will be one of the largest butadiene plants in the world, producing from petroleum at the rated capacity of 100,000 short tons a year.

The plant's annual capacity will represent nearly one-fourth of the total quantity of butadiene scheduled to be produced by the oil industry, sufficient to make 120,000 long tons a year of GR-S (Buna-S type) synthetic rubber.

It is the most unusual of all the butadiene projects in that it is a cooperative plant, designed, built and to be operated jointly by utilizing the full technological knowledge and experience of five major oil companies, and also having the benefit of data accumulated from all sources by the Rubber Reserve Co.

The butadiene plant will feed two copolymer plants adjacent to be run by rubber companies, each with a rated capacity of 60,000 long tons annually.

The Neches Butane Products Co. project had its inception Jan. 12, 1942. On that date Herbert Henderson, Gulf Oil Corp. vice president with long years of experience in refinery construction was called to Washington. He was told that large quantities of synthetic rubber must be produced in the U.S. before the stockpile of natural rubber became too greatly depleted as a result of Japan's invasion of the Far East. The government plan was to build a number of plants, some to produce butadiene from petroleum and others from alcohol, to break the butadiene bottleneck in Buna-S synthetic rubber production. Mr. Henderson suggested a plant of 100,000 tons annual capacity be built in Texas' Gulf Coast region, to be supplied with feed stocks from the nearby refineries



The skyline at Port Neches, Texas, of the five oil firms' butadiene plant. It is in reality two plants of equal capacity; the "North Plant" (right) is on-stream although some of the storage spheres were not painted when this picture was taken. "South Plant" has fewer towers because butadiene goes to "North Plant" for purification

of five oil companies and to be constructed and operated by the five contributing companies for the government without profit.

Government approval in principle was immediately given, and Mr. Henderson laid the plan before the five companies —Gulf Oil Corp., The Texas Co., Pure Oil Co., Socony-Vacuum Oil Co., and The Atlantic Refining Co.—all of whom had refineries at Port Arthur, Port Neches, or Nederland, Texas. They not only agreed to supervise jointly the construction and operation of the plant *without profit* but to furnish the services of management, advisory, technical, and legal committee members and pay their salaries and expenses. Government again approved and several committees, each comprising a representative from each of the five companies, were appointed to study the problem and develop a program. They recommended the present project, the butadiene plant to be built and run under their supervision. The two copolymer plants, which also were approved, are being operated by the B. F. Goodrich Co. and Firestone Tire & Rubber Co., respectively, for Rubber Reserve Co.

To carry out the butadiene program, the five oil companies, with government approval, organized the Neches Butane Products Co. as agent to supervise plant design and construction for Defense Plant Corp. and to operate the plant for Rubber Reserve Co. Mr. Henderson was made board chairman and W. H. Hoffman was made available by The Texas Co. to serve as president. The Lummus Co., New York, was retained as engineer-contractor for the project. The management, advisory, technical, legal, insurance, patent, and public relations committees, which had been functioning during the preliminary stages of the planning, continue to serve the Neches company at need and their members are on call by their respective chairmen. Salaries and expenses of committee personnel still are paid by their respective companies.

Bottlenecks Conquered

In undertaking this project, the oil industry assumed one of the toughest jobs in the war production program. It was called upon not only to produce butadiene in far larger quantities than ever before, but to adapt a process that would yield more from a barrel of oil than had been possible in any previous commercial operation and to utilize the remaining petroleum products for manufacture of 100-octane aviation gasoline and other war materials. The oil industry, pooling its research facilities, patents, and "know-how" with that accumulated by Rubber Reserve from the rubber and chemicals industries and the Alien Property Custodian, developed a process that would roughly use about 5% of a barrel of oil but leave the remainder available for production of aviation gasoline and other products.

The process as finally developed entailed the manufacture of butadiene from butane-butylene feed stocks by catalytic dehydrogenation of the butylenes (butene-1 and butene-2), removal of impurities to attain 98.5% pure butadiene, and return of the separated and purified normal butane, isobutane, and isobutylene (as dimer) to the refineries supplying the feed stock for further processing. The butadiene then was to be supplied to the two copolymer plants. The five participating companies, in turn, were to expand their facilities for production of the "B-B" cut supplied Neches at their own expense.

Acknowledgment

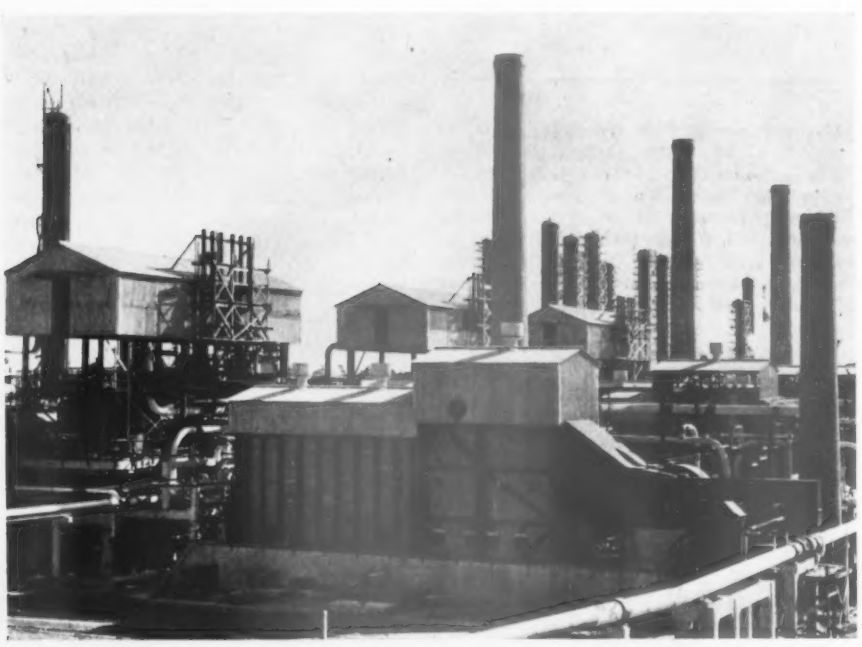
The photographs of the Port Neches butadiene plant used in this issue were supplied by the Neches Butane Products Co. and the Lummus Co., refinery engineers, the construction contractors.

(The two 60,000-ton copolymer plants consist of two identical pairs of units, each of 30,000 long-tons annual capacity, supplied with butadiene from Neches; styrene and other components of GR-S are supplied from other government plants operated by the chemical industry. They are of the same "standard unit" design described in NPN Technical Supplement for Aug. 4, 1943, p. R-358-362.—Ed.)

The Technical Committee, having decided what process to use and the main types of equipment required, then had to design the plant and get it built. The staff of the engineer-contractor, Lummus Co., was called on for help. Together they decided how many towers, tanks, boilers, storage spheres, compressors, etc. would be required, how big they were to be and where they were to be located with reference to one another. Then, still working together, the specifications and materials bills were written with all necessary details; the plant was built—on paper.

It was June, 1942, before actual construction began. Before that time the plant site of 314 acres was acquired near Port Neches, midway between Port Arthur and Beaumont, roads and railroad spurs were built, drainage canals dredged, and a high wire fence strung around the property. The Lummus Co., contractors on the job, then had to import employes and solve the terrific problems of housing and providing transportation for the 6000 men and women to be employed in building the plant. The nearby cities of Port Arthur, Port Neches, and Beaumont could not supply the number required, let alone provide housing and transportation facilities, because shipbuilding and other war industry also was making huge demands. Transportation of equipment was another difficulty, as this part of Texas long had been served by water to the extent that every refinery was a port in its own right. Tankers and freighters had been requisitioned by the Navy and the few railroad lines in the area were already overburdened by priority freight.

Two more serious "headaches" were encountered which for a time threatened



General view of dehydrogenation section where butadiene is made from butylenes. The single unit in the foreground is composed of, right, the steam superheater and, left, dehydrogenation reactors. Stacks in background exhaust flue gases used in superheating steam and heating butenes to reaction temperatures

The heart of the butadiene plant. View shows, left to right, reactants, superheaters, catalytic dehydrogenators, heat exchangers atop the setting for waste-heat boilers, and, right, some of the fractionator towers. Some of a group of pressure storage spheres are visible in the background

to delay the project's completion. First the marshy Texas soil was practically at sea level, and probings to find a solid foundation for towers and utilities revealed none at any reasonable depth. This was solved through creating firm foundations by sinking concrete piling as much as 40 feet into the wet subsoil. The second problem, even more serious, was securing the materials and fabricated vessels, turbines, pumps and compressors. The war building program then was at its height, and possibly the contractor's greatest difficulty was to find a vessel fabrication company able to accept orders for constructing the lofty steel fractionating towers, large auxiliary vessels, and steam generating equipment. Lummus engineers, in conjunction with the firm of Babcock and Wilcox, scoured the country for enough steel rolling equipment, hydraulic presses, electric seam-welders, and handling equipment to start their own vessel-fabrication shop at the plant site. All the steel fractionator towers, the largest of which is 14 ft. in diameter, 175 ft. high and weighing around 200 tons, as well as all horizontal accumulator drums, were built to A.P.I.-A.S.M.E. specifications on the site.

The completed plant will consist of two identical 50,000-ton units, together with central feed-and-product purification units, steam power plant, and cooling water unit. The butadiene units each have 21 fractionation towers, 6 dehydrogenator reactors, 3 steam superheaters, and 3 control houses. The solvent purification unit has 6 fractionators for solvent purification of feed and product, as well as the necessary accumulator drums and heat exchangers.

The process, as previous stated, is based on high-temperature low-pressure catalytic dehydrogenation of butenes to 1,3-butadiene, according to the equation:

$$CH_2{=}CH{-}CH_2{-}CH_3 \xrightarrow{\text{Catalyst}}$$

Butene-1

$$CH_2{=}CH{-}CH{=}CH_2 + H_2\cdot$$

1,3-Butadiene Hydrogen

The feed stock for this reaction is a combined butane-butene cut from catalytic cracking of petroleum at the five nearby refineries. As received, this mixed feed contains butane, isobutane, butene-1, butene-2 and isobutene; small amounts of propane and pentanes also generally are present.

Feed stock is supplied by pipeline from the refineries and stored in pressure vessels as a liquid until needed. No attempt is made to segregate the contribution of any individual refinery, because compositions are controlled by contract agreements with the suppliers. Upon withdrawal from storage, the raw liquid feed receives a light caustic wash to free it from light sulfur compounds and then is charged to a stripping column which separates the liquid into two streams. Overhead is butene-1, isobutene and isobutane as one stream; butene-2 and butane comprise the other. The overhead product serves as charge to a conventional cold-sulfuric acid plant which produces di-isobutylene dimer as one stream and unchanged isobutane and butene-1 as the other. The latter two

components are separated by extractive distillation with a solvent.

Bottoms from the initial fractionation, butene-2 and butane, are first depentanized to assure no C_5's and then separated by solvent extraction.

The feed for dehydrogenation consists of mixed butenes from the two solvent separations. Di-isobutylene and normal and isobutane are not required in the manufacture of butadiene, but since all are valuable raw materials for 100-octane aviation gasoline manufacture, they are returned to the five contributors. Stocks of these valuable materials are divided among the contributors on the basis of the analysis and quantity of feed stock they individually supplied. Return of separated hydrocarbons is by the same pipeline from whence they came, except that it now is contemplated to return di-isobutylene by tankcar rather than by pipeline.

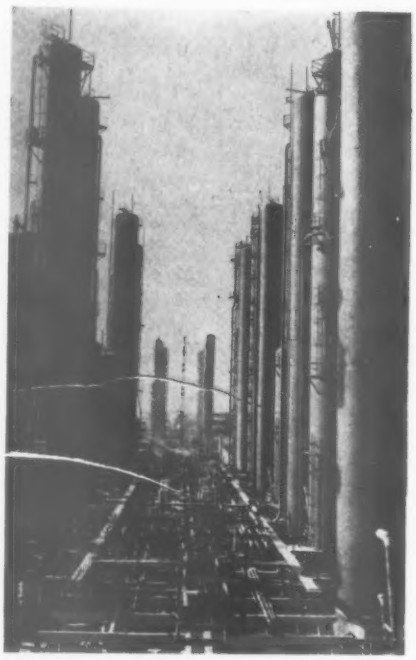
There is an additional point to this arrangement which should not be lost sight of, because of the saving of critical materials involved: All the contributing companies are engaged in the manufacture of 100-octane aviation gasoline and components, which requires the separation of butane, isobutane, and isobutylene. If each plant had to perform this separation of their "B-B" cuts individually, it would require each to install fractionating and other equipment, with all the attendant complications, delays, and expense to the 100-octane program. Neches had to install most of this equipment to clean up the butylenes required in the process but has no use for the other materials. Thus, by additional co-operation, an immense amount of steel, pumping and compressing equipment, and critically-scarce control instruments—as well as money, time, and labor—have been saved by everybody concerned, and the 100-octane program is that much further ahead.

The actual dehydrogenation is accomplished by mixing superheated steam with the butenes at high temperatures and charging under low pressure to a reactor containing a fixed-bed catalyst. Superheated steam is generated in a convection-type flue-gas recirculator superheater, fired by natural gas; butenes are heated in a similar manner.

The reactors, two for each of the units, are connected in parallel for intermittent on-stream operation. Suitable valves and cycle-timers are provided for switching flow of charge and regeneration-steam from one reactor to the other in automatic sequence.

After passing through the reactor, the hot gases flow through a waste-heat boiler. The somewhat cooled gases are then further cooled in heat exchangers and routed through steam-driven compressors before being charged to the purification area.

The cooled, compressed reactor-effluent consists of butadiene, hydrogen, unreacted butenes, steam, and other gaseous byproducts from dehydrogenation. This mixture is charged to a naphtha-absorber where water vapor is dropped out and hydrogen is separated. Naphtha then is stripped and the gases are conventionally depropanized. Bottoms from the depropanizer contain butadiene and unreacted butenes. The butenes are removed from the butadiene by successive extractive distillations and the butadiene is finally purified to 98.5% purity by straight fractionation. It is then ready for transfer to the copolymer plant. If storage is contemplated, however, a small amount of inhibitor must be added to the butadiene to prevent polymerization.



This has been termed "Butadiene Boulevard, the main street in the nation's butadiene production program". All 48 of the fractionator towers at Neches Butane Products Co.'s 100,000 tons a year plant are in these two rows. Some of these all-welded towers are 175 ft. high, weigh more than 200 tons, and all were fabricated at the plant site from flat steel plate

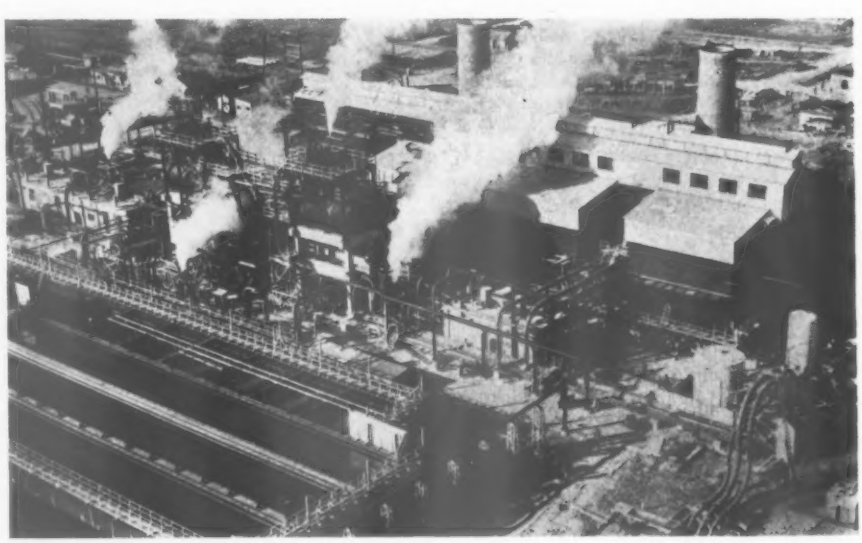
Butenes recovered in the final purification are of course returned to the reactors, while the other gases separated from the reactor-effluent are added to the purchased natural gas, to be consumed in the plant for steam generation, superheating steam, and other services.

Steam Generating Plant

The steam generating installation at the Port Neches plant is designed to produce 500 lb. gauge saturated steam from each of four boilers. Saturated steam at 450 lb. gauge will be delivered to pump and compressor drives, which are of the turbine type for the most part.

All boilers are gas-fired, although one is capable of handling a combination of gas and oil to permit disposal of any slop-oil which may accumulate during processing. Each is equipped with forced-draft gas burners. The one handling oil also has 4 oil burners in addition to the gas burners, oil being supplied to this boiler by a rotary fuel pump. All boilers have both forced- and induced-draft fans, an air preheater and 4 soot-blowers. Gas is used as primary fuel because it is both abundant and inexpensive in this part of Texas.

Treated water, to which has been added anhydrous disodium phosphate and sodium sulfite for scale and corrosion control, is fed to the boilers by centrifugal pumps at 650 lb. per sq. in. discharge pressure; each is driven by a steam turbine receiving saturated steam



Reputedly the largest steam-generating plant in Texas, this view shows the 50,000,000 lb. per day unit and water-treating facilities. Three of the four boilers already are enclosed and under test, preparing for the "North Plant" to go on-stream

at 450 lb. gauge and exhausting at 160 lb. gauge. A further load on these pumps is in supplying feedwater to the waste-heat boilers in the process area.

Boiler water, purchased from a local utility company, is chemically softened with "Amberlite" before being used for making steam. A clarification plant has been constructed which furnishes adequate filtered water from that available. To supply the softened water for delivery to the boilers, there are 7 filters, 6 softeners, 3 softened-water reservoirs, a filtered-water reservoir, and 3 coagulating basins. Provision has been made for later addition of another filter and another softener.

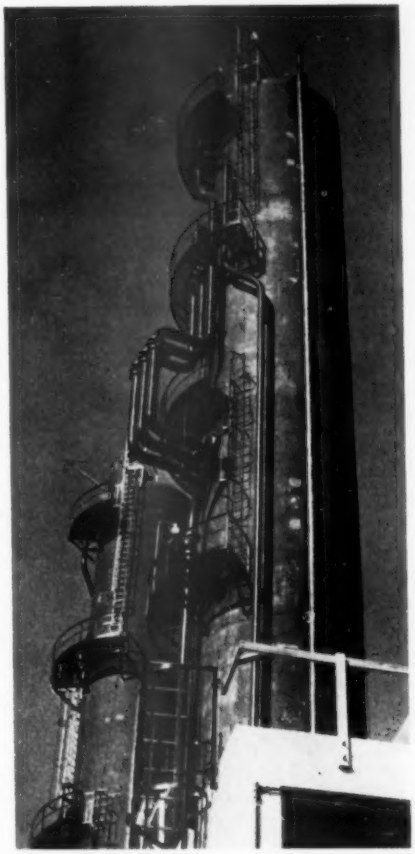
Considerable saving of both water for steam and gas for heating is effected through the re-use and condensation of all steam except that contaminated during processing and thereby uneconomical to purify for re-use. Condensate water is returned to the boilers through the same de-aerating feed-water heaters which supply the main boiler feed-water. Heat is saved by the use of waste-heat boilers forming a part of each dehydrogenation unit, and, further, through the re-use of high-pressure steam after exhausting from the turbines. Turbine exhaust pressure is around 160 lb. per sq. in. gauge into the 150-lb. steam line. This lower pressure steam is used to drive the instrument-air compressors, refrigeration equipment, the blowers and fans on the high-pressure steam superheaters, centrifugal feed (or products) pumps in the process area, fire-water pumps and plant-air compressors, exhausting into the 15-lb. steam line. Some of the 150-lb. steam also is used in re-boilers for fractionators and strippers, and, where more heat is needed, some of the 450-lb. steam from the high pressure line is used. Remaining process requirements are supplied from the 15-lb. steam line. Altogether, steam is used for three purposes before it returns to the boilers: For high-temperature heating (process), low-temperature reboiling, and for driving all pumps and compressors.

Part of the water plant has been described in connection with the steam power generating unit; additional water is required in process cooling and will be brought from the Neches river.

Equipment Control

To save critical metal and equipment, everything possible has been done to keep instrumentation and equipment at the minimum consistent with safety and efficient operation. For a single example, where hydraulic-operated remote-control valves normally would be used, hand-operated valves have been substituted.

Each of the two butadiene plants also has separate control-houses. Instruments in these houses control reactor on-stream and regeneration cycles, temperature, pressure, and flow rates of streams during the preparation of feed and product purification. Here also, control of waste-heat boiler operation is lodged, as well as cooling-water supply.



Fractionator columns, butadiene purification unit, showing piping and construction detail

Because much of the operations require exceedingly close cuts in fractionation, it is frequently necessary to control for heat input rather than by temperature, pressure, or reflux rates. A glance at the boiling points given in Table 1° for some of the materials handled emphasizes this point.

Table 1—Boiling-Points of "B-B" Hydrocarbons and Butadiene

Compound	Boiling-Point, °F, 1 atm. Pres.
n-Butane	30.92 to 31.46
i-Butane	13.64
Butene-1	23.0
Butene-2 (cis)	33.8
Butene-2 (trans)	36.5
Isobutylene	21.2
1,3-Butadiene	26.6

For example, the last purification step in the production of 98.5% minimum purity butadiene involves the separation of any remaining butene-2 from it by straight fractionation. From the table, it will be seen that 1,3-butadiene boils at 26.6° F. under atmospheric pressure, while butene-2 (cis) boils at 33.8°F. This means the entire temperature gradient over the tower must not exceed a maximum range of less than 10° F. at atmospheric pressure. Since these gases are under pressure to reduce the volume of products handled, the working temperature range is less than 4°F. under actual process conditions. Thus better control is attained by controlling heat-input than by attempting to maintain constant conditions through temperature-sensitive controllers.

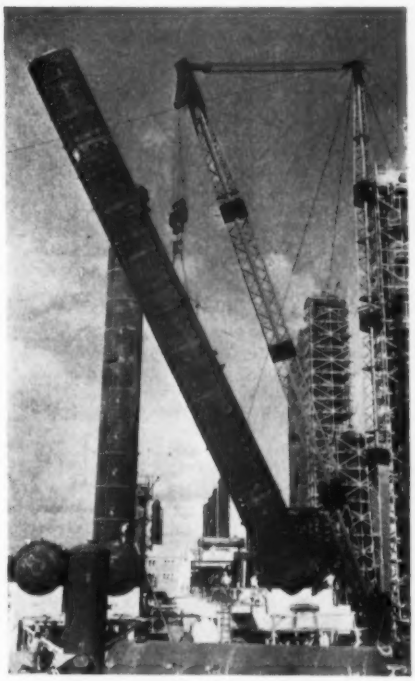
°"Handbook of Chemistry and Physics", 22d Ed., 1937, p. 512-793.

Plant Statistics

An idea of the size of the Neches plant and complexity of operations there is reflected in some of its "vital statistics".

The plant site contains 314 acres criss-crossed by roads and drainage ditches, feed and product supply lines, steam lines, cooling water conduits, and outfall canal, railroad lines and rails for traveling cranes. Electrically-operated instruments and lighting load alone is expected to consume approximately 1000 kva. daily. On a 24-hour day operating basis, a total of 900 men (3 shifts) will be required to operate the plant. It took about 6000 men and women to build it.

An interesting feature of the plant, aside from statistics, is the arrangement of the various units for accessibility during cleaning, repair, and maintenance.



The last of 48 skyscraper steel fractionator towers in the oil industry's largest single wartime project is lifted into its final resting place. Fabricated in one piece from steel plate at the plant site, this 175-ft. high monster, weighing 200 tons, was cradled on a flat-car and run on rails to the spot. Then riggers, using one of the largest mobile derricks ever employed, wrapped cables around it and hoisted it, upright, atop a 15-ft. concrete foundation. Sometimes the placement job required no more than 20 minutes, start to finish

As will be seen from the several general views, there are two rows of fractionator towers, extending in straight lines from the "north" plant to the "south" plant. Down this avenue, popularly known as "Butadiene Boulevard", runs a traveling crane, the height of which can be regulated telescope-fashion for optimum working level and to permit it to clear overhead steam- and products-lines, as well as electric cables. The two reactor areas in the "north" and "south" plants are similarly serviced, while a fourth crane is reserved for the boiler-house area. These will be used in handling heat-exchangers, piping, valves, and other heavy parts removed for repair or during re-installation.

Management Personnel

Following is a list of the management personnel of the Neches Butane Products Co.:

Directors

For The Atlantic Refining Co.—E. J. Henry, vice president; W. F. Stroud.
For Gulf Oil Corp.—W. A. Slater, vice president; Herbert Henderson, vice president.
For The Pure Oil Co.—C. B. Watson, vice president; J. P. Langfitt, asst. to vice president.
For Socony-Vacuum Oil Co., Inc.—W. F. Burt, director; Dr. J. B. Rather, director of research.
For The Texas Co.—M. Halpern, vice president; G. R. Bryant, general manager, refining department.
For Neches Butane Products Co.—W. H. Hoffman, president.

Officers

Herbert Henderson, chairman of the board.
W. H. Hoffman, president.
J. B. Rather, vice president.
H. P. Arbuckle, secretary-treasurer.
F. W. Cooper, assistant secretary-treasurer.

Committees

Technical Committee:

duBois Eastman (Ch.), The Texas Co.
P. W. Cornell, Gulf Oil Corp.
M. J. Fowle, The Atlantic Refining Co.
J. Happel, Socony-Vacuum Oil Co., Inc.
C. A. Porter, The Pure Oil Co.
A. H. Schutte, The Lummus Co.

Legal Committee:

Eldon Young (Ch.), Gulf Oil Corp.
A. T. Foster, Socony-Vacuum Oil Co., Inc.
E. S. Morris, The Pure Oil Co.
George W. Ray, The Texas Co.
W. F. Stotz, The Atlantic Refining Co.

Patent Committee:

A. M. Houghton (Ch.), Gulf Oil Corp.
N. E. Birch, The Atlantic Refining Co.
Donald Dickerson, Socony-Vacuum Oil Co., Inc.
Edward H. Lang, The Pure Oil Co.
W. M. Stratford, The Texas Co.

Management Advisory Committee:

W. H. Hoffman (Ch.), Neches Butane Products Co.
J. S. Allen, The Pure Oil Co.
B. H. Barnes, Gulf Oil Corp.
John W. Newton, Socony-Vacuum Oil Co., Inc.
R. W. Stewart, The Atlantic Refining Co.
Frank Wallace, The Texas Co.

Insurance Committee:

S. E. McKee (Ch.), The Texas Co.
W. V. Keeley, The Pure Oil Co.
C. H. Reller, The Atlantic Refining Co.
C. I. Richards, Socony-Vacuum Oil Co., Inc.
H. J. Smith, Gulf Oil Corp.

Public Relations Committee:

James Tanham (Ch.), The Texas Co.
Byrne Bauer, Socony-Vacuum Oil Co., Inc.
C. H. Hathaway, Gulf Oil Corp.
F. H. Marling, The Pure Oil Co.
Richard Rollins, The Atlantic Refining Co.

Postwar Rights Secured in Neches Agreement

By A. M. Houghton

How the exchange of patent rights and technical data regarding butadiene manufacture was worked out for the cooperative Neches Butane Products Co. is described by A. M. Houghton, patent counsel for the Gulf Oil companies, chairman of the Neches Patent Committee.

WHEN the proposal was made that a group of five refiners having refineries in the Port Arthur, Texas, district join hands in a comparatively non-profit enterprise for the manufacture of butadiene for the account of Rubber Reserve Co., among important matters requiring attention and consideration were questions relating to the necessary exchanges of patent rights and technical information. In particular, it was necessary to make arrangements to acquire adequate rights and technical information from other companies having experience in the manufacture and purification of butadiene.

Consequently, among the various committees formed as an incident to the creation of Neches Butane Products Co. was the Patent Committee. Its principal function was to advise Neches and the five owner companies in regard to patent matters. One member of the Patent Committee was appointed by each of the owner companies, the membership and affiliations being as follows: A. M. Houghton, chairman, Gulf Oil Corp.; W. M. Stratford, The Texas Co.; Donald Dickerson, Socony-Vacuum Oil Co.; Edward Lang, Pure Oil Co.; Norbert E. Birch, The Atlantic Refining Co. Due to the fact that Mr. Birch was serving on the staff of the Office of Petroleum Coordinator during part of 1942, W. F. Stotz, also of The Atlantic Refining Co., served for a time as his alternate.

Serve Without Charge

As in the case of the other Neches committees, the owner companies undertook to supply the services of members of the Patent Committee without charge to Rubber Reserve Co. or to Neches.

The Patent Committee began its activities by meeting with the Legal Committee of Neches and with representatives of Rubber Reserve Co., to consider the nature of the arrangements which had at that time been made by Rubber Reserve in respect of patent rights and technical information relating to the manufacture of butadiene. The committee learned that Rubber Reserve, through the mechanism of the so-called General Butadiene Agreement of Feb. 5, 1942, had brought together a number of oil and chemical companies which had developed or had experience with processes for manufacturing and purifying butadiene. This agreement established a limited exchange of technical information and patents in the butadiene field under a system operating through Dr. E. R. Weidlein, Technical Advisor of Rubber Reserve. It also established a system for the settlement of claims relating to the use by any party of the technical information and butadiene patents of any of the others.

However, the General Butadiene Agreement, while providing for the extension thereof to other companies, required that any new company undertaking to manufacture butadiene for the account of Rubber Reserve Co. should, as a condition to such extension, own or have the right to operate a complete process for producing butadiene. Since Neches had just been formed and since

There's A Petroleum Side To the Rubber Issue

The great amount of publicity now being given the butadiene-from-alcohol plants has led to some public expression of doubt concerning the petroleum industry's rubber program . . . However, there is another side to the debate of the relative economic and technological advantages of making synthetic rubber from alcohol or from petroleum. . . . Some of the points on petroleum's side are discussed in the editorial in this issue of NPN's Technical Section. . . . Read Widening Horizons on pg. R-184.

its owner companies had not had extensive experience in this field, it was necessary for Neches to acquire adequate rights in order to fit into the program.

Rubber Reserve Co. had made certain provisions for the acquisition of such rights by New Suppliers through the mechanism of the so-called Supplemental Agreement, also of Feb. 5, 1942, between Rubber Reserve Co., Standard Oil Development Co., Shell Development Co., Phillips Petroleum Co. and Universal Oil Products Co., and ratified by Jasco, Inc., M. W. Kellogg Co. and the Lummus Co. This Supplemental Agreement made certain provisions for licensing new suppliers under certain of the butadiene patents of these "oil company parties" to the General Butadiene Agreement.

License Held Deficient

During its first meetings, the Neches Patent Committee came to the conclusion that the type of license made available through the provisions of the Supplemental Agreement was not entirely adequate from the standpoint of Neches Butane Products Co. and other New Suppliers, and particularly from the standpoint of post-war rights. The committee directed its first efforts toward negotiation of an option to acquire rights for commercial post-war operations. During the course of these negotiations the committee pointed out to Rubber Reserve Co. that the arrangements already in effect between Rubber Reserve and others were not adequate to support the type of license which Neches and other new suppliers would need.

As the result of these representations, Rubber Reserve Co. undertook to revise the arrangements between itself and the oil company parties, with the result that Rubber Reserve and the oil company parties entered into the so-called Substitute or Oil Industry Process Agreement, superseding the Supplemental Agreement referred to above. In accordance with the terms of this substitute agreement, the oil company parties agreed to extend licenses to new suppliers (such as Neches) for the use of the "Oil Industry Process", at royalties consonant with the "ceiling value" of technical information and butadiene patents established under the General Butadiene Agreement. (*See appendix for summary of Substitute Agreement.*)

However, before the license thus made available was executed, the decision was made by Rubber Reserve Co. to modify the operations of Neches. These modifications included the substitution of butenes for butane as the charging stock. It was also decided that it would be advisable for Neches to carry out the segregation of butenes from the total feed stock supplied by the owner companies, rather than to have the individual feed stock suppliers attempt such segregation in their individual refineries.

Further Revision Necessary

The Neches Patent committee therefore pointed out to Rubber Reserve Co. at this time that further revision of the substitute agremeent and the licenses offered thereunder were required in order to coincide with this change in the operating picture. Rubber Reserve Co. then took the necessary steps to effect an amendment to the substitute agreement, providing for the additional rights necessary to permit Neches to conduct the butene-segregation operations, without additional royalty, during the term of the General Butadiene Agreement.

Immediately following such amendment of the Substitute Agreement, the

A. M. Houghton, chairman, Patent Committee, Neches Butane Products Co.

patent committee considered and recommended the acceptance of a license by Neches, and Neches then entered into the standard form of license so provided. This license was executed with Phillips Petroleum Co. acting as the licensing agent for the oil company parties mentioned above.

The Neches Patent Committee also participated in the certification of the necessary license and other joint agreements relating to the creation and operation of Neches Butane Products Co., under the provisions of Sect. 12 of the Smaller War Plants Act.

The committee will continue to be active in all matters pertaining to patents, as they may affect Neches and its relations with Rubber Reserve Co. and its owner companies. It is presently considering more or less comprehensive proposals for the exchange of patent rights and technical information between Neches and the five owner companies, as well as such further arrangements as may be necessary in order to implement the general program of Rubber Reserve Co.

Appendix

Summary of Substitute Agreement Regarding Exchange and Use of Technical Information and Patent Rights under Oil Industry Processes for Production of Butadiene, as Issued by Rubber Reserve Co.

Date of agreement Feb. 5, 1942; amended Oct. 12, 1942.

Field of Agreement: Manufacture of butadiene by "Oil Industry Process", defined as production of butadiene from butane or butylene by thermal or catalytic dehydrogenation, the recovery of butadiene from mixed gases containing butadiene in recoverable proportions, and the purification and chemical stabilization of butadiene. Agreement also covers preliminary steps used in recovering butane and butylene from mixed gases.

License to Rubber Reserve Co.: No direct licenses to Rubber Reserve Co. are provided, the purpose of the agreement being to provide for exchange of licenses and technical information between Oil Company Parties and to provide for licensing New Operators and New Suppliers for use of Oil Industry Process.

Licenses to Others: (a) Oil Company Parties exchange royalty-free licenses covering Oil Industry Process and right to license others under their respective patents.

(b) Each of the Oil Companies undertakes to grant licenses in specified form to New Suppliers and to new operators of Government plants, upon request of Rubber Reserve Co. Such licenses have been issued to Neches Butane Products Co., Sinclair Rubber, Inc., Cities Service Refining Corp., and Eastern States Petroleum Co., Inc.

(c) The exchange of licenses between the Oil Companies is limited to the term of the General Butadiene Agreement of Feb. 5, 1942, and to the manufacture of butadiene for sale or delivery to Rubber Reserve Co. thereafter. The licenses granted to new operators and New Suppliers remain in effect throughout the life of the patents except with respect to separation of isobutylene by polymerization or acid absorption and regeneration. Polymerization rights remain in effect during the term of the General Butadiene Agreement; acid absorption and regeneration rights remain in effect throughout the war and six months thereafter.

Royalties: (a) Exchange of licenses between Oil Industry Parties is royalty-free.

(b) Royalties payable by licensees (new operators and New Suppliers) are: 1/8th cent per pound of butadiene manufactured for Rubber Reserve Co. during the term of the General Butadiene Agreement; 3/8ths cent per pound of butadiene manufactured for Rubber Reserve Co. thereafter; 5/8ths cent per pound of butadiene manufactured by licensee for its own use or sold or delivered to others than Rubber Reserve Co. and its nominees.

Technical Information: The agreement provides for the full exchange of technical information relating to the "Oil Industry Process" between the Oil Industry Parties and their licensees.

Canada's Complete Rubber Plant

Refines Own Feed Stocks from Nearby Refineries; Annual Output 34,000 Tons of Buna-S, 4000 Tons of Butyl

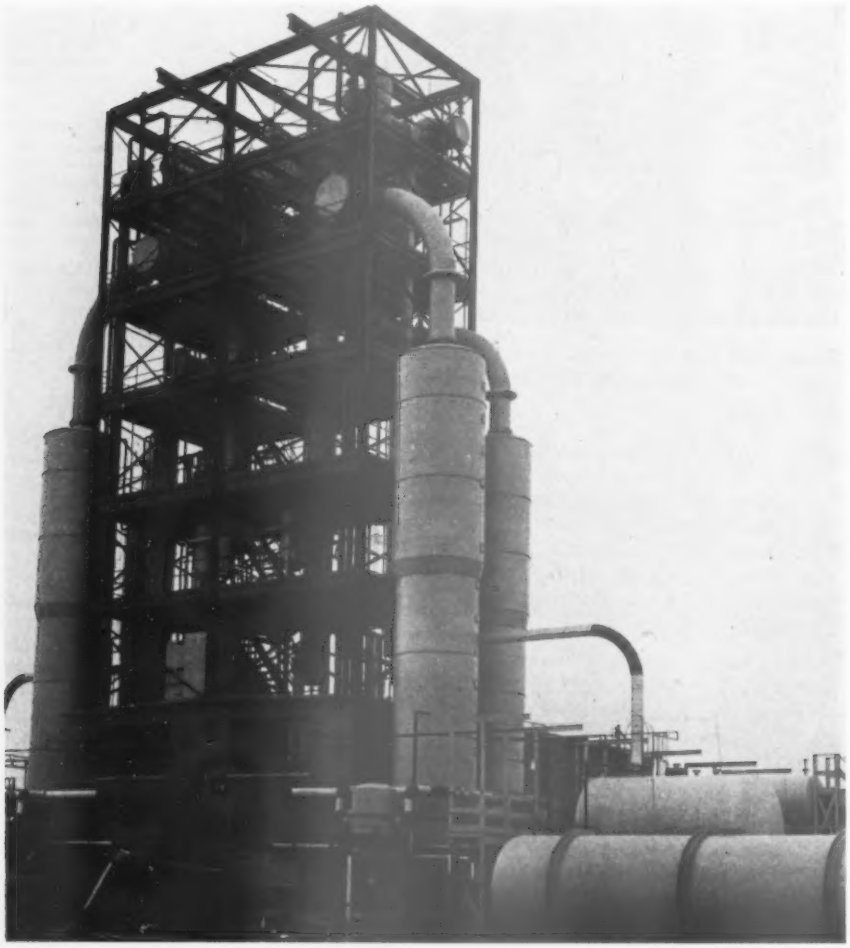
THE only synthetic rubber plant in the world to refine its own feed stock as well as make Butyl and Buna-S synthetic rubber, went into full-scale operation the last of February. It was built near the plant of the Imperial Oil Ltd. at Sarnia, Ont., and is operated for the Canadian government by Polymer Corp., Ltd. It will produce an estimated 34,000 long tons of Buna-S and 4000 long tons of Butyl rubber annually. Facilities cost about $48,000,000, required 18 months for construction.

The Sarnia plant is unique because it recovers isobutylene, butylenes and ethylene from cracked refinery gases and light liquids furnished by the nearby refinery. Benzene is imported from coke oven producers at Sault Ste. Marie and Hamilton, Ont. These raw materials are converted into butadiene and styrene, which are then copolymerized into two kinds of rubber. Some plants make only butadiene or styrene, importing "missing" components from other manufacturers.

The plant site at Sarnia consists of 185 acres. The first tree on the forest-covered site was felled June 10, 1942. Thereafter a force which at times totaled 5579 men and women toiled seven days a week through some of the area's worst weather in history to build a plant requiring only an estimated 1294 men and 325 women for its operation. They fought clay, heavy snows, spring thaws, and equipment and delivery delays, to cover 80 city blocks with equipment, lay six miles of sewers, five miles of roads, 125 miles of medium and large steam, oil and water lines, and countless miles of smaller pipes, electric cables, telephone wires and automatic control lines.

To carry the vast quantities of materials going into the project has required 9000 freight cars; to distribute them on the property took 40 tractors, 40 cranes and 120 trucks. Contractors used an estimated 5,000,000,000 bricks, 102,700 cu. yd. of concrete, 16,500,000 board feet of lumber, 5000 tons of re-inforcing steel, 156,000 tons of crushed stone, 25,000 medium and large valves of all kinds, and hundreds of thousands of nails, bolts, screws, nuts, and other items in the building, exclusive of the towers, tanks, heat exchangers, boilers and motors which really do the work. And all Canada is proud of the result.

On Sept. 29, 1943, half capacity Buna-S production started by using styrene made at the plant and butadiene imported from the U. S.—less than 14 months after construction began. By the end of December the balance of the copolymer plant was running and at about the same time the Butyl plant started on-stream. To produce its rated capacity of 38,000 long tons annually of the two synthetic rubbers, an estimated 500,000 tons of coal, 54,000,000,000 gal. of water, 22,800,000 gal. of petroleum light ends, 2,250,000,000 cu. ft. fuel gas, 2,700,000 gal. benzene, and enough brine to contain 3500 long tons of salt must be supplied. In addition, large amounts of soap, acids, catalysts, inhibitors, and other materials are required. Brine comes ready to use from the salt mines near Sarnia, transported to the plant in tank trucks.



Styrene purification tower at the Sarnia plant during construction

Raw Feed Is Cracked Refinery Gas

First vital job was to increase the cracking capacity of Imperial Oil's refinery, adjacent to the rubber plant site. This was done by adding a "Super-suspensoid Cracking Coil" to the four others already serving that plant. While details surrounding its operation are restricted, it may be said that in the suspensoid process a finely pulverized catalyst is mixed with some of the cracking stock to form a slurry, thence proportioned into the main feed stream, heated to cracking temperature, cooled, filtered and fractionated as in conventional thermal cracking operations. Gases and light ends, totaling respectively 19,400,000 cu. ft. and 6255 bbl. daily, are supplied to Polymer Corp., which, in turn, removes needed C_4's and ethylene, burns some of the light uncondensables for fuel, and returns the balance plus unneeded light petroleum liquids to the refinery for gasoline blending. Naphtha and gas oil serve as charging stock for cracking.

At the Polymer Corp. plant, ethylene from the refinery is fractionated from the fuel gas, as are propane, with any butane-butylene cut and liquefied petroleum gases as such. Approximately 700 b/d of propane and 1500 b/d of "light gasoline" are returned to Imperial Oil. Ethylene goes to the styrene unit for conversion while the B-B cut is retained

for further purification and segregation of isobutylene, normal and iso-butane (returned to Imperial), and butenes-1 and -2.

Raw B-B cut next is separated into its components by a combination of cold acid extraction (for isobutylene) and distillation and solvent extraction to concentrate the two butenes from the remaining normal and isobutane. Isobutylene then is ready for polymerization with isoprene (which is shipped in from chemical plants) to make butyl rubber. Butadiene may be used instead of isoprene.

Styrene—Butadiene Manufacture

The raw materials for butadiene manufacture are butene-1 and butene-2. The two compounds are mixed, heated to high temperatures, and, with highly superheated steam, flow into a dehydrogenator reactor where by catalytic action, two atoms of hydrogen are removed according to the reaction:

$$CH_2 = CH - CH_2 - CH_3 \xrightarrow[\text{Steam}]{\text{Catalyst}}$$

$$CH_2 = CH - CH = CH_2 + H_2$$

Subsequently, by solvent extraction and distillation, butadiene is freed of butenes, water vapor and hydrogen. Unreacted olefins are repurified and recycled to the dehydrogenator.

Ethylene and benzene are the raw materials for styrene manufacture. This material is also a plastic base and was in commercial production for this utilization before the war. Briefly, the process involves catalytic addition of the two compounds to form ethylbenzene. This intermediate product then is freed of unreacted ethylene and benzene by distillation, and pure ethylbenzene catalytically dehydrogenated to form styrene. A final purification step precedes copolymerization with butadiene into Buna-S[1].

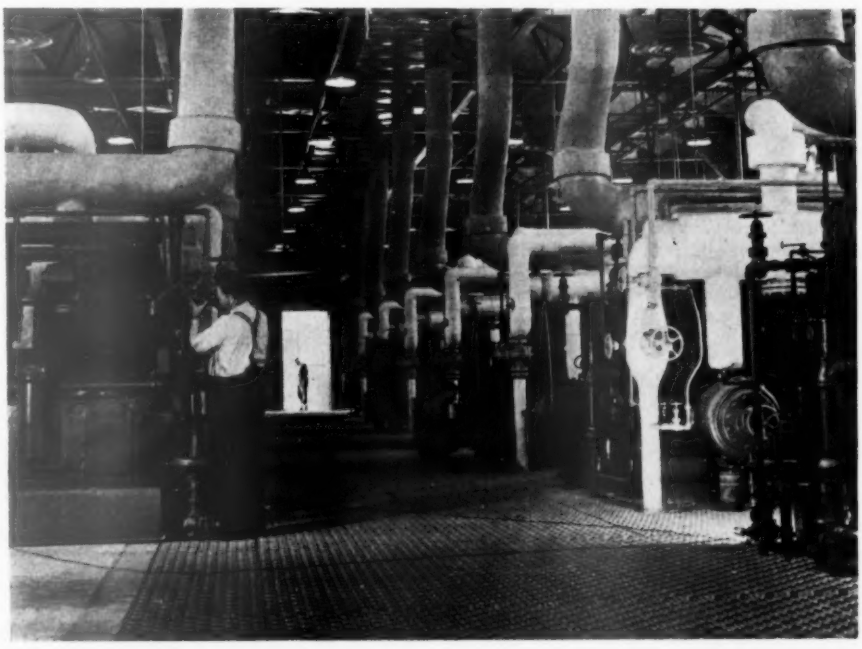
Designed capacity of the styrene unit is 10,000 short tons, of which 9000 tons are used by Polymer and the balance shipped to the U. S. for use by copolymer plants there. Before Polymer's butadiene unit was in operation, styrene also was shipped to the U. S. in exchange for butadiene with which to operate Polymer's Buna-S plant.

Control-room for the ethyl-benzene building of the styrene unit. Girl on the left is the college-graduate who keeps the instruments in repair, the one in the center keeps the technical records. The sole male, on the right, is the operator, who has two assistants and three helpers to keep the whole building in operation

The styrene unit is operated for Polymer by Dow Chemical Co. of Canada. Including administrative, engineering, technical, operational, and maintenance staffs, this company employs only 94 persons. Such a small staff is made possible by the design of the unit itself, employing extensive automatic control. For example, the ethylbenzene unit requires one operator and two helpers per eight-hour shift; the purification and dehydrogenation units require only three men between them. Thus the equivalent of three fair-sized "factories" calls for only six men per shift. In addition, one woman, a college graduate, keeps in repair the 200-odd control instruments, while others compile the technical records.

Butyl and Buna-S Plants

The Buna-S plant comprises two identical units having a combined capacity of 34,000 long tons a year. It occupies an area 1200 by 250 ft. The process of copolymerzation has been well-described in the technical literature[2] and, briefly, in involves the copolymerization of a soapy emulsion of three parts butadiene



Compressor section of Butyl rubber making unit. A total of 15 compressors, developing pressures of from 250 to 450 lbs. per sq. in. are required to refrigerate the isobutylene-isoprene reaction mixture to —150°F. during the polymerizing reaction

[1]See NPN Technical Supplement for Jan. 6, 1943, pp. R-46-47.

[2]Ibid, pp. R-23-31; Aug. 4, 1943, pp. R-358-362 and R-368-374.

Buna-S latex as it flows from the reactors after "flashing" to remove unreacted butadiene, styrene and kill the polymerizing catalyst. Latex next is washed, dried and baled for shipment

to one part styrene in the presence of a catalyst. The latex then is coagulated by brine and acid, washed, dried, and baled for shipment.

Butyl rubber is, essentially, the copolymer of an olefin with a diolefin; usually the olefin is isobutylene and the diolefin is isoprene, although butadiene can be used. Isobutylene is first redistilled to remove any moisture and undesirable fractions remaining from its initial extraction from refinery cracked gases and then mixed with about 2% isoprene and a special diluent before going to the reactors. Just preceding entry to the reactors, the mixture is chilled to approximately -150° F., using both ammonia and ethylene for refrigeration. This low temperature also is maintained in the reactor. The solid catalyst is dissolved in the same diluent used for the raw materials, chilled to -100° F. and pumped into the reactor through jets. Reactor mix is sufficiently agitated at all times to maintain a thin slurry, with feed stock and catalyst being continually added to the reactor and reaction product continuously withdrawn into flash drums.

When the reactor effluent reaches the flash drums, a temperature of +150° F. is encountered, which causes unreacted isobutylene and the diluent to flash into vapor; at the same time any remaining active catalyst is destroyed. Water also is injected for this latter purpose. Diluent and unreacted isobutylene are separated by fractional distillation, then are available for recycling to the reactor or are in part discarded to prevent accumulation of catalyst poisons in the polymerization system. The thin slurry of Butyl and water flows from the bottom of the flash drum and thereafter is dried in much the same way as Buna-S[3].

Steam and Power Plant

The steam and power unit supplying utilities for Polymer is the largest in Canada, having a rated capacity of 1,375,000 lb. of steam per hour at 450 lb. per sq. in. pressure. If converted into electricity, there would be enough to light 1,200,000 sixty-watt light bulbs. Most of the steam produced is used in the various processing units, and the remainder is used to generate 32,000 h.p. of electricity for light and power throughout the plant. Two turbo-generators are rated at 10,000 KWH each, a third at 4500 KWH; normal daily load averages about 11,000 KWH.

The steam and power plant cover little more than an acre. The building is 124 ft. high, contains five boilers, and has space for a sixth. Five smokestacks are provided for the boilers, each 186 ft. high. The five furnaces are each 24 ft. square by 100 ft. high, weigh 190,000 lb. and unlike any other furnace in Canada, are suspended from two 4½-in. U-bolts supported by re-inforced concrete—a method of suspension which allows for 4-in. heat expansion. Boilers are covered by 60,000 ft. total of high-temperature insulating cement, made principally from magnesia. So efficient is the insulation that the hand can be held on the furnace wall without discomfort, seven inches from the hottest point where temperatures range from 2500 to 3000° F.

R. L. Hearn heads Polymer's engineering staff. He co-ordinated work of the contract engineers and generally supervised construction. Mr. Hearn was loaned to Polymer by the Hydro-Electric Power Commission of Ontario, where he is executive assistant to the chairman

Air for combustion is furnished by a 200-h.p. electric blower and is preheated by stack gases. Stack draft is maintained by an individual 400-h.p. fan for each boiler.

There are two boiler feedwater treaters having a combined filtered and treated water capacity of 192,000 gal. per hour. Water is supplied from a pumping station on the St. Clair River; capacity is 6,250,000 gal. per hour total from its six steam-driven pumps. At need, two electrically driven standby pumps can supply 2,395,000 gal. per hour more. This water, which varies in temperature from 34 to 70° F. is also used for cooling and, because of its low maximum temperature, eliminates the need for cooling towers. This abundant supply of cooling and process water, together with Imperial Oil's refinery already being located there, was mainly responsible for the location of Polymer's plant at Sarnia.

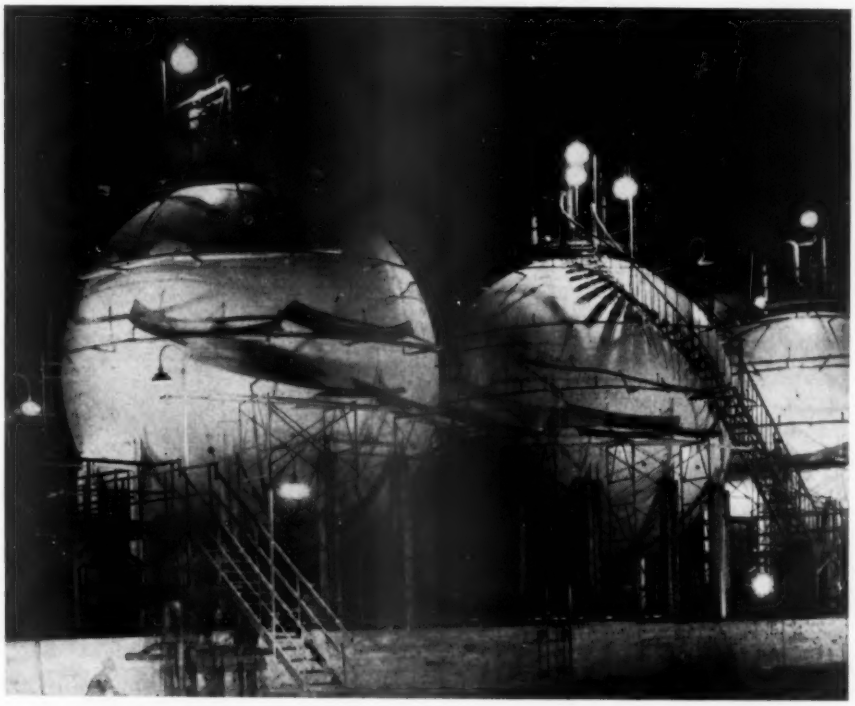
Fuel for the boilers amounts to 500,000 tons of bituminous coal annually, stockpiled in the summer at the rate of two shiploads a week. Coal is carried from Polymer's dock on three 54-in. conveyor belts made of natural rubber and measuring respectively 192 ft., 132 ft., and 60 ft. Great "stork" Caterpillar tractors scoop it up and pile it into a 65-ft. mountain 1200 ft. long and 400 ft. wide. From the stockpile it is carried to a crusher on a 30-inch conveyor. After crushing, it is lifted 100 ft. on another 30-in. belt 582 ft. long to the top of the bunkers, where it is distributed into five bunkers by a tripper moving back and forth on rails.

Coal falls from the bunkers by gravity into a pulverizer which grinds it finer than 200 mesh with 20% coarse rejection. Subsequently airborne, it passes through three pipes into the furnace. Mill and air-fan are both driven by a 175-h.p. electric motor; there are two mills for each boiler setting.

The Polymer Corp. did not have to work out any processing problems except those concerned with the steam and power and the feed preparation units. Technical problems on feed preparation

J. R. Nicholson, ex-Deputy Controller of Supplies for Canada, is secretary and managing director for Canada's Polymer Corporation Ltd.

[3]For additional details on this process see NPN Technical Supplement for Sept. 1, 1943, pp. R-399-401.



Two 51-ft. 12,000-bbl. Hortonspheres at the Sarnia synthetic rubber plant seen at night. These are in the butadiene-storage area, in the construction stage
National Film Board of Canada photographs

were worked out in detail by Dr. R. K. Stratford and R. H. Smith, both of the research department of Imperial Oil Ltd. Patents, registered in the U. S. and Canada, were pooled and made available to Canada.

The Standard Oil Development Co. was selected about the end of February, 1942, to handle design and process engineering for the petroleum end of Polymer's program. First construction engineers chosen were E. B. Badger & Sons, Boston, and M. W. Kellogg Co., New York. H. G. Acres & Co., Niagara Falls, Ont., was appointed consultant to handle power and utility programs. Polymer's engineers, headed by R. L. Hearn, of the Hydro-Electric Power Commission of Ontario, was responsible for correlating work of the contract engineers, and for general supervision.

The construction, transportation, and erection of the 165-ft. butylene-concentration tower at the Polymer plant presented unusual engineering problems. The tower is 12.5 ft. in diameter and when loaded on three flat-cars, stood nearly 17 ft. above the track. It weighed 150 tons and was built in the Lachine, Que., shops of Dominion Bridge Co. When it was ready to load on the cars, the actual job took only 15 minutes, but engineers had sweated for two weeks making drawings and designs to determine how the job should best be done.

Once loaded and put on the siding, the tower was strapped down and large front-and-rear tie-rods placed to prevent forward and backward motion.

A special "high-ball" train was run from Lachine to Sarnia, consisting of two cabooses for the 8-man crew, the three flat-cars bearing the tower, an old rock car as "floater" between load and engine, and a big 6100-type engine. Maximum speed regulation for the train was 15 m.p.h., but even passenger-expresses took the sidings for the little crawler to pass and five days were required for the 500-mile trip. When it arrived, four 120-h.p. Caterpillar tractors moved it to the 10-ft. concrete base waiting for it. It took a 200-h.p. electric motor, assisted by the largest "cat" tractor on the place, to get enough "heave" on the derrick cables to haul it into place. This took another three hours and then everybody was happy.

Construction of cracking facilities required approximately a month. The suspensoid coil was designed and engineered by M. W. Kellogg Co., constructed by Canadian Kellogg Co., Ltd., and is operated for the Canadian government by St. Clair Processing Corp., Ltd., a subsidiary of Imperial Oil Ltd.

The ethylene recovery and the butylene extraction units were designed by M. W. Kellogg Co. and constructed by Canadian Kellogg Co., Ltd.; isobutylene extraction unit was designed by Standard Oil Development Co., engineered by Stone and Webster Engineering Corp., and built by Canadian Kellogg Co.

The butadiene unit was designed by Standard Oil Development Co., engineered by E. B. Badger & Sons Co., built by Canadian Kellogg Co., Ltd., and is operated for Polymer by St. Clair Processing Corp., Ltd.

The styrene plant was designed by Dow Chemical Co. and built by Anglin-Norcross (Ontario) Ltd.

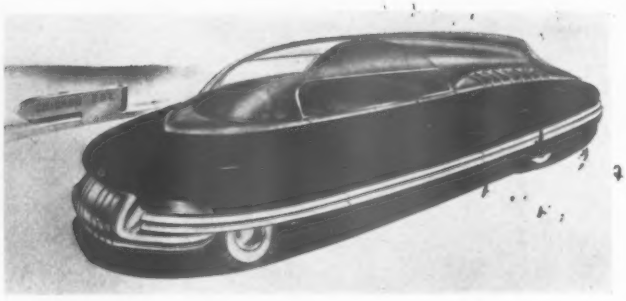
The Buna-S unit was designed by Blaw-Knox Co., engineered by J. Gordon Turnbull Co. and built by Piggott Construction Co., Ltd. It is operated for Canada by Canadian Synthetic Rubber Ltd., a subsidiary of four Canadian rubber processing companies: Goodyear Tire & Rubber Co., Firestone Tire Co., Dominion Rubber Co. (subsidiary of U. S. Rubber Co.), and Goodrich Tire & Rubber Co.

The Butyl plant was designed by Standard Oil Development Co., engineered by Stone & Webster Engineering Corp., and built by Anglin-Norcross (Ontario) Ltd. It is operated for Canada by St. Clair Processing Corp., Ltd.

WHERE THE FUEL GOES

A PURSUIT PLANE, at a cruising speed of 200 m.p.h. requires one gallon of gasoline for every four miles of flight.

OWI



Factors Affecting the Antiknock Performance of Postwar Gasolines*

By T. H. Risk**

Petroleum refiners will have at their disposal after the war almost twice as many practical methods and processes for making gasoline blending stocks as before the war. They will also have the benefit of an increased knowledge of actual engine requirements, as is provided by such means as the relatively new borderline knock test method which correlates knocking tendency with engine speeds. These two factors combined will allow the production after the war of motor fuels consisting of gasoline blends "tailored" to actual road conditions.

By projecting past trends in motor fuel antiknock quality, values of 83 A.S.T.M. octane number for premium grade motor fuel and 79 A.S.T.M. for regular grade are indicated in 1945. It is pointed out, however, that in the future the gasoline blends produced by the new methods and with increased knowledge of actual service conditions will perform on the road better than is indicated by the laboratory octane numbers.

IT IS POSSIBLE EVEN now to make a reasonable prediction of the antiknock value of postwar fuels in terms of laboratory octane number, the conventional yardstick for measuring this characteristic. However, owing to tremendous advances in refining technique during the war and to other important factors, laboratory-determined octane numbers alone may result in inaccurate conclusions as to the "true" antiknock quality of these postwar fuels when used in a particular vehicle.

For example, it is quite within the bounds of possibility that postwar fuels made by the new processes and rating 83-85 octane number by the A.S.T.M. laboratory method might give better antiknock performance on the road than prewar aviation fuel of 87 octane number.

It is the purpose of this paper to show that the question of antiknock value of postwar gasoline is not as clear cut as mere octane number would indicate and to point out some of the factors involved. In the main, there are four subjects to consider:

1. How new wartime refinery equipment, now used for making aviation fuel, will be used to make motor gasoline.

2. The possible variations in chemical composition of gasolines and the effect of such variations on the road antiknock behavior of the gasolines.

3. The effect of possible variations in engine and vehicle design on the antiknock ratings of the gasolines.

4. The probable laboratory octane values of postwar gasolines to be used as the "convenient" means of expressing fuel antiknock quality for refinery control.

Obviously, a complete discussion of these factors leading to a single conclusion is impossible in the light of present knowledge and is well beyond the scope of this discussion. Rather, it is our purpose to show, by means of a limited number of examples, why it is necessary to consider the relationship of these factors when considering the antiknock quality of postwar fuels.

Part I—New Refinery Equipment

How will the new wartime refinery equipment be used after the war? Most of this new equipment was installed for the purpose of boosting the production of 100-octane aviation gasoline. By the time the war is over, capacity to produce aviation fuel will greatly exceed the forecasted peacetime demand. What will happen to excess production, or, put another way, what will happen to the facilities not needed to produce 100 octane gasolines? (1)

Conceivably the petroleum industry could continue to produce 100-octane gasoline up to the full limit of capacity and dump the excess into motor gasolines. To determine the effect of this procedure, an estimate of postwar aviation gasoline consumption is required. Estimates of this demand vary considerably from about 50,000 b/d to 150,000 b/d. Due to wartime restrictions, the excess cannot be stated in actual figures, but it has been estimated that, if the excess postwar aviation gasoline were used in this manner, the over-all effect would be a 2-3 octane number °°° increase in motor gasoline octane number. This relatively slight increase in octane number would be expensive since aviation gasoline costs the refiner considerably more to make than motor gasoline.

It is, therefore, much more likely that the new refinery equipment not needed to make aviation gasoline after the war will be used more directly to produce gasoline suitable for automobiles, trucks, and busses. The exact manner of utilization will vary within the industry and will be based on such factors as:

1. Relative demand for various grades of fuel, i.e., aviation, premium, house-brand, and third grade.

2. General refinery economics, i.e., equipment available, crude supplies, etc.

3. Postwar car requirements and competitive demands.

A survey of refinery equipment available shows that the American refiner now has at his disposal almost twice as many practical methods or processes for making gasoline blending stocks as he had before the war. It is unlikely, however, that expensive components such as alkylate and hydrocodimer will be used

*Presented before the following meetings of the Society of Automotive Engineers: Minneapolis, May 13, 1943; Milwaukee, Sept. 23; Philadelphia, Oct. 13; Cincinnati, Nov. 19; Indianapolis, Dec. 9.

**Technical Service Department, Ethyl Corp.

***Barnard, D. P., and R. F. Marschner: Forecast of Motor Gasoline Developments, Technical Section, National Petroleum News, Feb. 2, 1943, pg. R-57.

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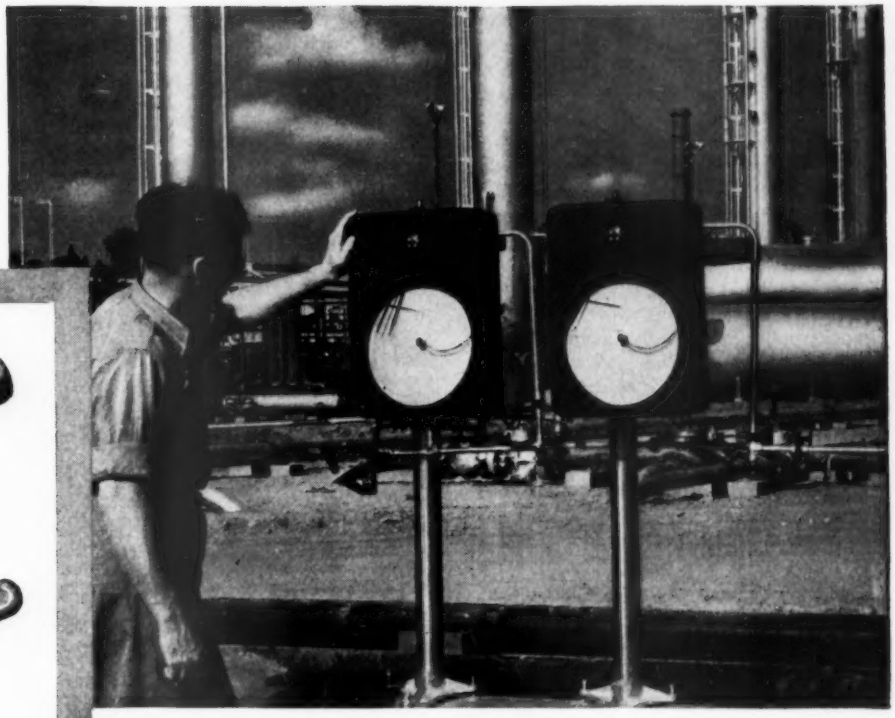

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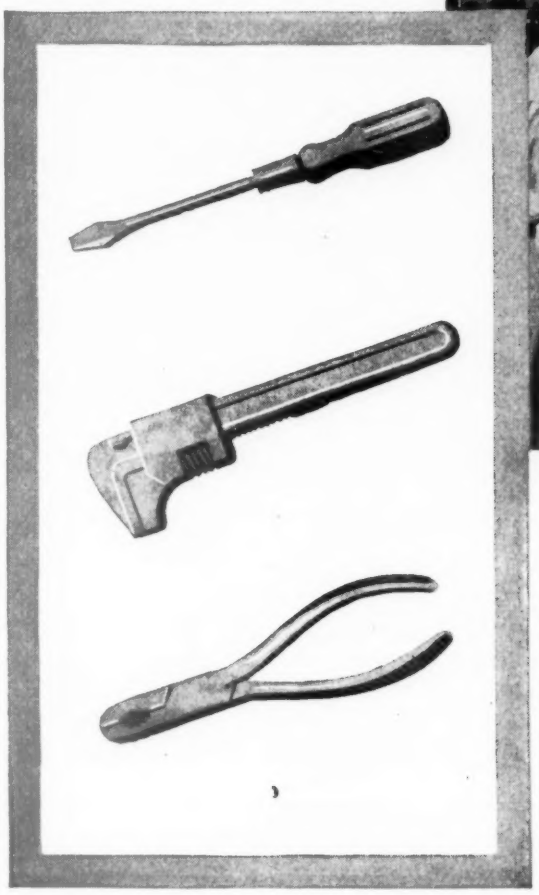

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in the manufacture of motor gasoline after the war. In Table I an attempt has been made to forecast the blending stocks that may be used in appreciable quantities, together with their antiknock values.

Increase Anti-Knock Value

It is clear from the table that the new blending stocks will increase the antiknock value of the finished gasolines, but it should be emphasized again that laboratory octane number does not tell the full story. New characteristics derived from improved refining processes and the blending possibilities of these stocks will not be too well indicated by laboratory octane number alone. The very fact that there is more than one test method is evidence that the "end use" of a gasoline has a considerable effect on its antiknock quality. Actually, a gasoline can and usually does have several different laboratory numbers. Selection of the most representative will depend on the intended use of the fuel—not merely on some inherent quality of the fuel.

There are three general methods of rating fuels in CFR laboratory knock test engines, and to avoid misunderstanding they are reviewed briefly in Table 2. All of these methods require the use of the CFR single cylinder test engine but, as indicated, employ different operating conditions. In all cases, the test fuel is compared in knock intensity to blends of reference fuels of known octane number. The matching blend determines the octane number of the test fuel.

When discussing "octane numbers" without other qualification, the ASTM Motor method is generally implied.

Part II—Blending Refinery Stocks

The statement that laboratory ASTM octane number does not necessarily give a true picture of the road antiknock behavior of all gasolines will come as no revelation to technical men in the oil and automotive industries. At the time it was adopted by the Cooperative Fuel Research Committee in 1932, the ASTM laboratory method was designed to rate fuels in terms of octane numbers which would be comparable to the average road octane number of these fuels when tested by the CFR Uniontown road test procedure. (3) Even at that time the ASTM laboratory octane number did not in all cases give correlation with road results. Since little gasoline was then marketed that did not give reasonable correlation, the method was considered satisfactory for all practical purposes.

Largely because of improved refinery methods, more and more gasolines have been produced which show better antiknock characteristics in cars on the road than is indicated by laboratory ASTM octane values. Because of this, much research work has been directed toward the development of improved test methods.

When using the CFR Uniontown road test method, difference in fuels could be shown as indicated in Fig. 1. Fuel A, the saturated type gasoline, (4) knocks at low speeds, while Fuel B, the unsaturated type gasoline, knocks at high speeds. This method, however, rates fuels on the basis of knock intensity regardless of the speed range wherein the knock occurs. Ratings are assigned to the test fuels by comparing their knock intensity to that of blends of secondary reference fuels. As shown in Fig. 1, both test fuels A and B have maximum knock intensities equal to that of an 80-octane reference fuel blend and, therefore, both are given a road rating of 80-octane in spite of the obvious difference in knocking tendency with respect to speed.

Borderline Method Developed

In view of these shortcomings and since no idea of fuel antiknock behavior is indicated outside of the actual knocking range, it was obvious that a road test method giving more information was required.

The borderline knock test method, adopted by the CFR as a standard procedure in 1940, gives more information of the type sought by automotive engineers and petroleum technologists. With this method the road antiknock performance of a gasoline is indicated by means of a curve instead of a number. A borderline curve shows, graphically, a fuel's ability to tolerate spark advance

TABLE 1—Components of Motor Fuel and Aviation Fuel

Motor Fuel Pre-War	Average Octane No. A.S.T.M. Motor	C.F.R. Research
Straightrun gasoline	55	55
Natural gasoline	65	65
Thermally cracked and reformed gasoline	70	80
Polymer gasoline	80	92–95
Ethyl Fluid		
Additional Post-War Components		
Catalytically cracked gasoline	78–80	90–92
High Aromatic { Hydroformed	80	90–92
High Aromatic { Cycloversion	80	92–94
Superfractionated straightrun gasoline	70–75	70–75
Isomerized straightrun gasoline	70–75	70–75

Aviation Fuel Pre-War	Average Octane No. A.S.T.M. Motor	C.F.R. Research
Straightrun and natural gasoline	70–75	72–77
Alkylate and hydrocodimer	90	90–92
Isopentane and/or neohexane	95	95
Ethyl Fluid		
Additional Post-War Components		
Catalytically cracked—2nd and 3rd pass	80–82	88–92
Superfractionated straightrun gasoline	70–75	70–75
Isomerized straightrun gasoline	70–75	70–75
Cumene	Very high blending value	

TABLE 2

Laboratory Octane Rating Methods (2)

Test Method	A.S.T.M. Motor	C.F.R. Research	1-C Aviation
Operating Conditions			
Speed, rpm	900	600	1200
Coolant Temp., °F.	212	212	374
Mixture Temp., °F.	300	125	220
Spark Advance, BTC	Variable with Comp. Ratio	13	35

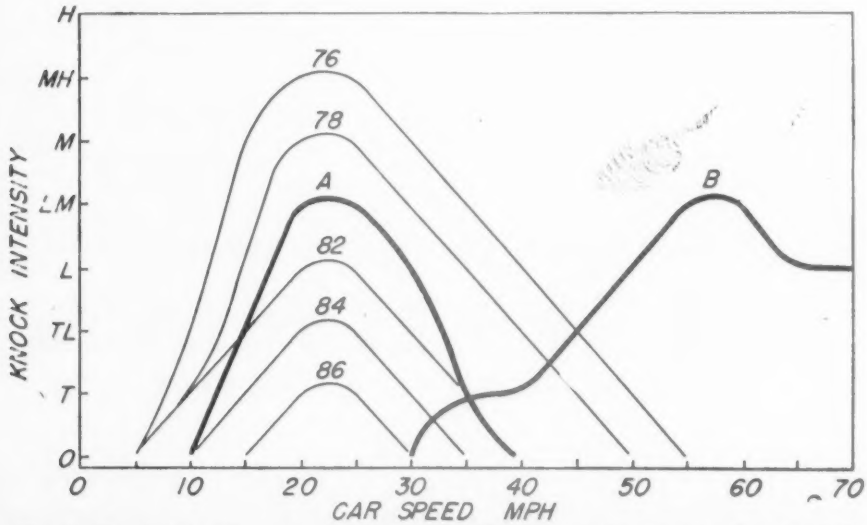

Fig. 1—Knock intensity curves: Fuel A, highly saturated type gasoline; Fuel B, highly unsaturated type gasoline

Cycloversion

A WARTIME PROCESS THAT FITS POSTWAR PLANS

This new catalytic process enables both small and large refiners to make premium base stocks for aviation gasoline from cracked naphthas. Postwar the process offers wide flexibility in both charging stock and end products.

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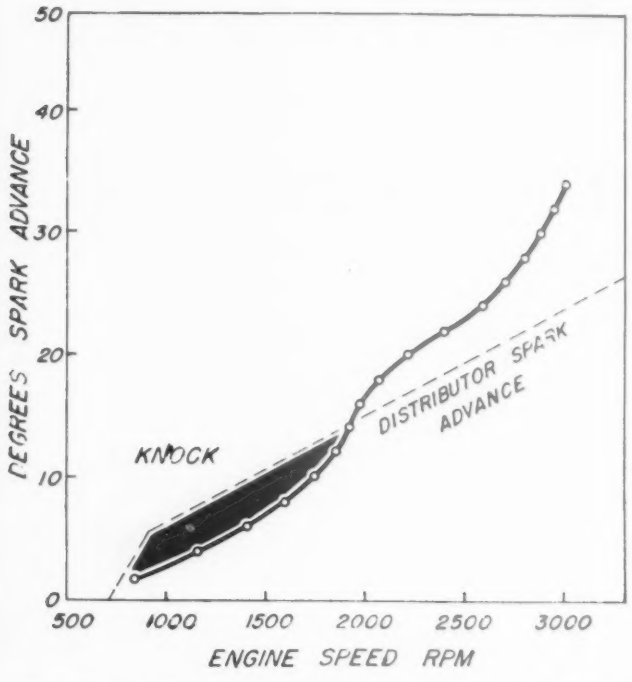


Fig. 2—Borderline knock curve: method used to obtain curve for any fuel

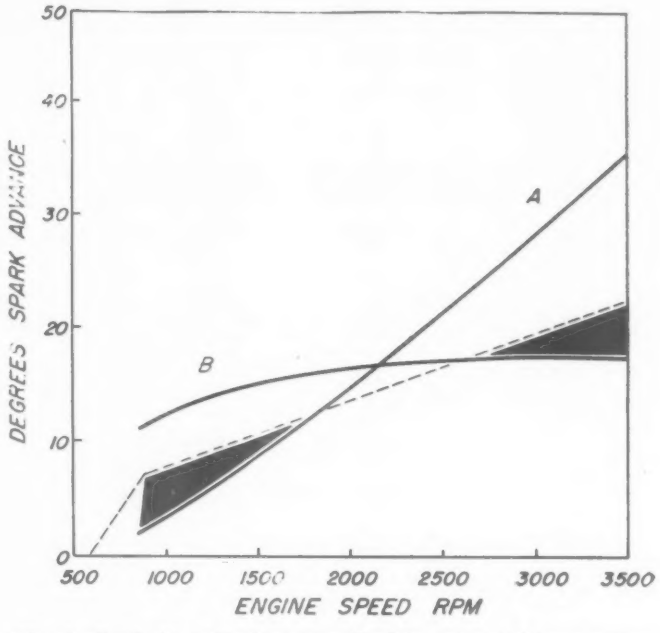


Fig. 3—Borderline knock curves: Fuel A, saturated type gasoline; Fuel B, unsaturated type gasoline

throughout the engine speed range. As the name implies, it represents the dividing line between non-knocking and knocking operation.

For testing by this method the test car is equipped with a fixed or non-automatic distributor that can be varied manually by the driver, a suitable spark advance indicator, and an engine tachometer. The procedure for determining the borderline curve for a fuel is as follows: The spark is set manually to a relatively low advance, usually 2 to 6 degrees before top dead center. The car is slowed down to as low a speed as possible in high gear, generally about 6 to 8 mph and then accelerated with wide-open throttle. The speed at which knock-die-out occurs is noted. This gives one point on the borderline curve—representing the two dimensions, spark advance and knock-die-out speed. The spark is then advanced 2 degrees and the entire procedure repeated to give the second point on the curve. This process is continued until the complete curve has been established for the entire spark advance and engine speed range under consideration.

Plotting Test Data

Borderline test data usually are plotted as shown in Fig. 2. The light dotted line represents the distributor-spark-advance curve for the particular engine in which these tests were conducted. For a fuel not to knock in this car, it must be able to tolerate at least as much spark advance at all speeds as that produced by the distributor-advance mechanism. Wherever the solid line representing the borderline curve for the test fuel falls below the distributor-spark-advance curve, the engine is considered to be knocking. The borderline curve, for this particular fuel, indicates that it will knock at relatively low speeds in the range from 700 rpm to 1800 rpm.

In this example, the actual knock-die-out points obtained on the road are indicated by the heavy dots to illustrate the number of points obtained in the development of a curve of this type. The individual points are not shown on the borderline curves given hereafter, but they all were obtained and recorded in a similar manner.

Using the borderline method, as shown in Fig. 3, we get a much better idea of the difference in road antiknock behavior of the two fuels "A" and "B" previously rated by the CFR Uniontown method. The "A", or saturated type, knocks severely in the low speed range, from 800 to 1800 rpm but is much better than the engine requires at high speeds. On the other hand, the "B", or unsaturated type, has excellent low speed antiknock characteristics but knocks at high speeds, above 2800 rpm.

Obviously a better fuel than either of the above would be one with a borderline curve which was parallel and slightly above the distributor spark advance curve of the car throughout the whole speed range, thus insuring knock-free operation. This is by no means a hopeless idea. By blending various refinery stocks the shape of the borderline curve can be materially changed to obtain a better "fit" between engine and fuel. We submit, however, that conventional laboratory octane number alone would give little or no clue to the fuel characteristics needed to accomplish this end.

In some instances conventional laboratory octane values are actually misleading. Take the case of a saturated type fuel which is similar chemically to the straightrun gasolines marketed extensively some years ago. The borderline curves for this gasoline, clear and with various concentrations of tetraethyl lead, are shown in Fig. 4. Judged on the basis of improvement in laboratory octane numbers, this type of gasoline is very "susceptible" (5) to tetraethyl lead. An addition of Ethyl Fluid to give a concentration of 3 cc. of tetraethyl lead per gallon causes the antiknock rating to increase 13.5 octane numbers as shown by the Motor method octane rating.

Rates At All Speeds

On the road, however, the principal effect of the addition of tetraethyl lead is a marked improvement in high speed antiknock quality with relatively little improvement at low speeds. Thus, a marked improvement in octane number does not necessarily mean a comparable gain in terms of road performance. It should be noted, however, that this fuel is the "insensitive" (6) type, i.e., the CFR Research method number is essentially the same as the ASTM Motor method octane number.

By comparing the borderline curves with the distributor-spark-advance curve, as illustrated in Fig. 4, it is possible to select a fuel that will not knock in this particular engine at any speed. Obviously blends "A" and "B" fall short of the ideal by a wide margin. Blend "C" is almost good enough but not quite. Thus, by process of elimination, we find that an entirely satisfactory fuel would contain about 1.6 cc. of tetraethyl lead and that the octane number by both the ASTM and Research methods would be

FUEL NO	TEL CC/GAL	OCTANE NUMBER MOTOR	OCTANE NUMBER RESEARCH	CAR	
A	0.0	80.0	80.5	YEAR	1941
B	0.5	85.0	86.0	COMP. RATIO	8.0-1
C	1.5	89.5	90.5	NO. CYL'S	8
D	3.0	93.5	93.0	HEAD TYPE	C.I.

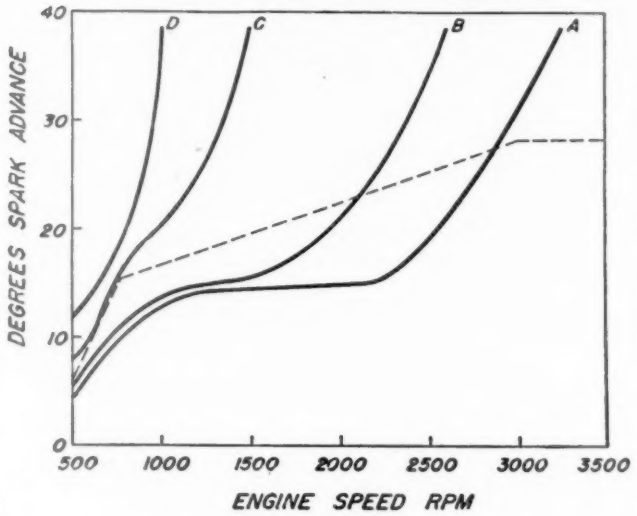


Fig. 4—Borderline knock curves: saturated type gasoline showing road lead susceptibility

FUEL NO	TEL CC/GAL	OCTANE NUMBER MOTOR	OCTANE NUMBER RESEARCH	CAR	
A	0.0	82.0	94.5	YEAR	1941
B	0.5	82.5	96.5	COMP. RATIO	8.0-1
C	1.5	84.0	98.0	NO. CYL'S	8
D	3.0	85.0	99.0	HEAD TYPE	C.I.

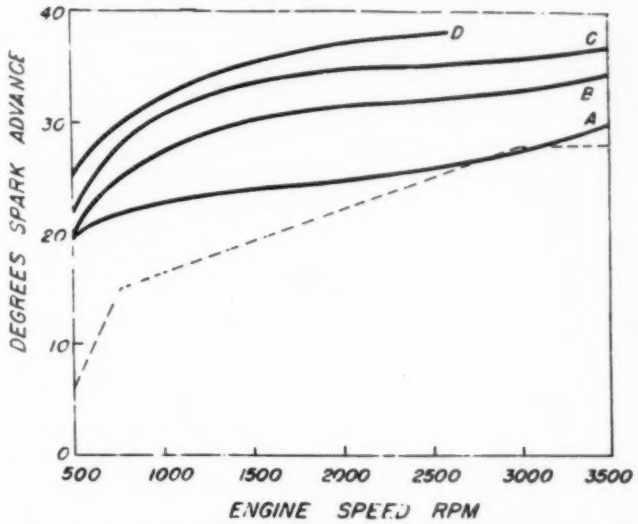


Fig. 5—Borderline knock curves: unsaturated type gasoline showing road lead susceptibility

FUEL NO	TEL CC/GAL	OCTANE NUMBER MOTOR	OCTANE NUMBER RESEARCH	CAR	
A	0.0	81.0	87.0	YEAR	1941
B	0.5	83.0	89.5	COMP. RATIO	8.0-1
C	1.5	86.0	93.0	NO. CYL'S	8
D	3.0	88.0	95.0	HEAD TYPE	C.I.

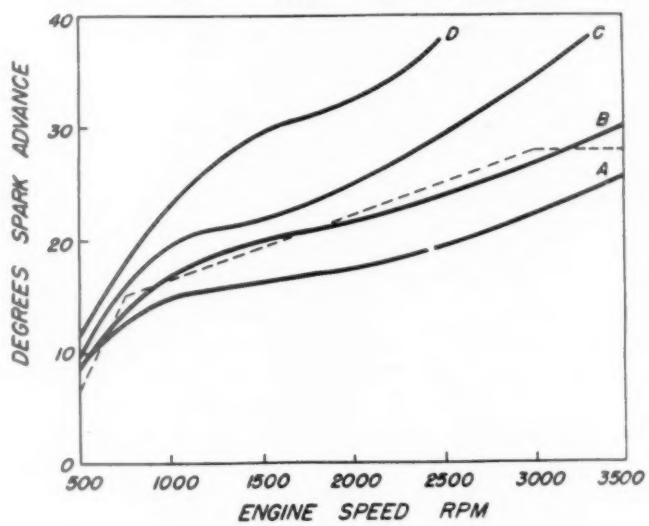


Fig. 6—Borderline knock curves: blended gasoline 50% saturated-50% unsaturated showing road lead susceptibility

FUEL NO	TEL CC/GAL	OCTANE NUMBER MOTOR	OCTANE NUMBER RESEARCH	CAR	
A	0.0	79.0	88.0	YEAR	1941
B	0.5	82.0	91.5	COMP. RATIO	8.0-1
C	1.5	85.5	94.0	NO. CYL'S	8
D	3.0	87.0	97.0	HEAD TYPE	C.I.

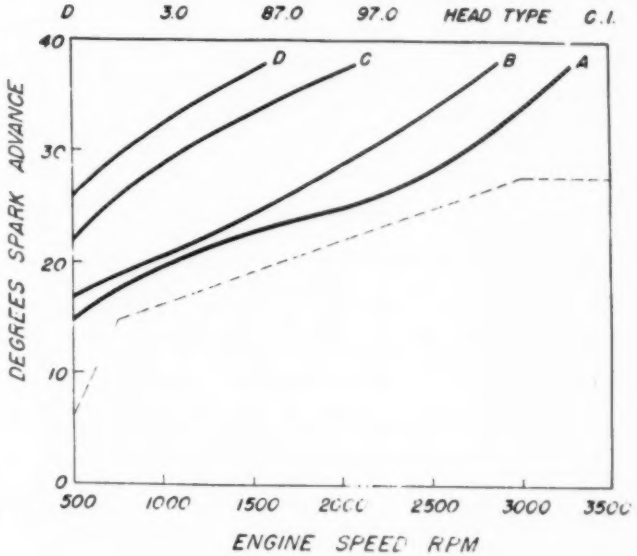


Fig. 7—Borderline knock curves: selectively blended gasoline showing road lead susceptibility

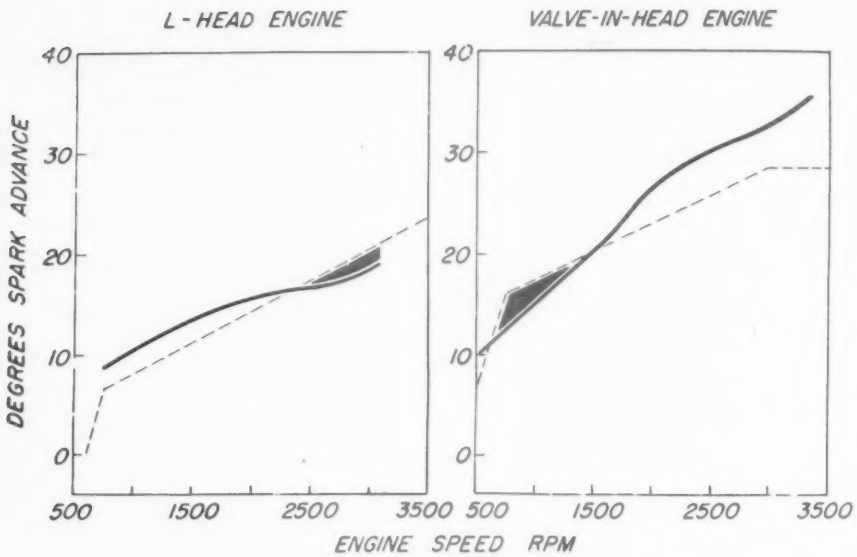


Fig. 8—Borderline knock curves for blended gasoline in L-head and Valve-in-Head Engine

about 90.

The lack of correlation between conventional laboratory octane number and road antiknock quality is equally apparent in a fuel of quite a different type. The example is a highly unsaturated stock, the borderline curves for which, clear and with various concentrations of tetraethyl lead, are shown in Fig. 5. Rated in terms of laboratory octane number this gasoline has a low tetraethyl lead susceptibility. The addition of 3 cc. of tetraethyl lead raises the laboratory antiknock value by only 3 octane numbers, as compared with 13.5 for the saturated type of fuel. Yet, with respect to road performance, the fuel is more suitable—in this particular engine—than the saturated type, although there is a tendency to knock in the high speed range. The addition of tetraethyl lead improves this fuel most at high speeds where the unleaded stock is inherently weak. Here again, the "road effect" is not properly indicated by laboratory octane number. For this engine a satisfactory fuel of this unsaturated type would contain only a small amount of tetraethyl lead, approximately 0.2 cc., and would have an ASTM Motor method rating of 82.0 to 82.5 octane number. Being a sensitive type of fuel, the Research method rating would be considerably higher, about 95 octane number.

Results Through Blending

It is obvious from the foregoing that a blend of saturated and unsaturated types may result in a fuel of better overall characteristics. Borderline curves for such a fuel, a 50-50 blend, clear and with various concentrations of tetraethyl lead, are shown in Fig. 6. We now have three variables, two blending stocks and Ethyl Fluid.

The tetraethyl lead susceptibility of this combination of gasolines by laboratory knock methods is about the average of the saturated and unsaturated stocks —7.0 octane numbers with 3 cc. of tetraethyl lead. The road response is more "even" than for either stock alone, although here again there is a definite tendency especially with high tetraethyl lead concentrations, to effect more improvement at high speeds than at low speeds. In this case, a gasoline slightly better than blend "B" is required—probably 85 Motor method and 90 Research, with a lead content of about 0.7 cc.

This is an example of what can be achieved by blending two simple combinations of base stocks. With the new refinery processes now available, innumerable combinations are possible. To give some idea of the enormous possibilities due to blending alone let us examine a special blend, clear and with several concentrations of tetraethyl lead. Borderline curves are shown in Fig. 7. This gasoline is the result of selective blending, (7) i.e., the control of hydrocarbon type with respect to distillation range. In this case when tetraethyl lead is added, we obtain an almost uniform increase in both low and high speed antiknock quality. A gasoline of this type having an ASTM octane number of 79.0 and a Research octane number of 88.0 will be satisfactory for this car.

Following is a summary of the antiknock ratings in terms of laboratory octane number of the 4 types of gasolines examined thus far:

	Octane Number	
	ASTM	CFR
Type of Gasoline	Motor	Research
A, Saturated	90.0	90.0
B, Unsaturated	82.5	95.0
50-50 Blend	85.0	90.0
Special Blend	79.0	88.0

By blending at the refinery, it is possible to produce fuels varying by as much as 11 ASTM Motor method octane numbers which, under the conditions illustrated, will have essentially comparable road antiknock performance. While these examples may represent extreme conditions, it is reasonable to expect that future gasolines will be more like the special blend, i.e., "tailored" to do a particular job. And like the special blend, when in actual service on the road, these fuels of the future will probably rate considerably better than laboratory ratings would indicate.

The sizable variations between actual road antiknock performance and laboratory octane numbers, as shown above, are probably due to the combined effect of physical and chemical factors not usually considered when determining the rating of a gasoline by the conventional laboratory procedure.

Part III—Effect of Engine and Vehicle Design

In the preceding discussion, differences in antiknock quality were illustrated by the performance of different gasolines in one type of engine. Now, however, it is our purpose at this point to demonstrate the effect of different engine types upon the antiknock performance of the same gasoline.

In general, the valve-in-head engine is inclined to knock more at low speeds than the L-head engine, whereas the L-head engine usually knocks more severely at high speeds. These varying characteristics emphasize the importance of using engines of various types when determining the general antiknock quality of a fuel.

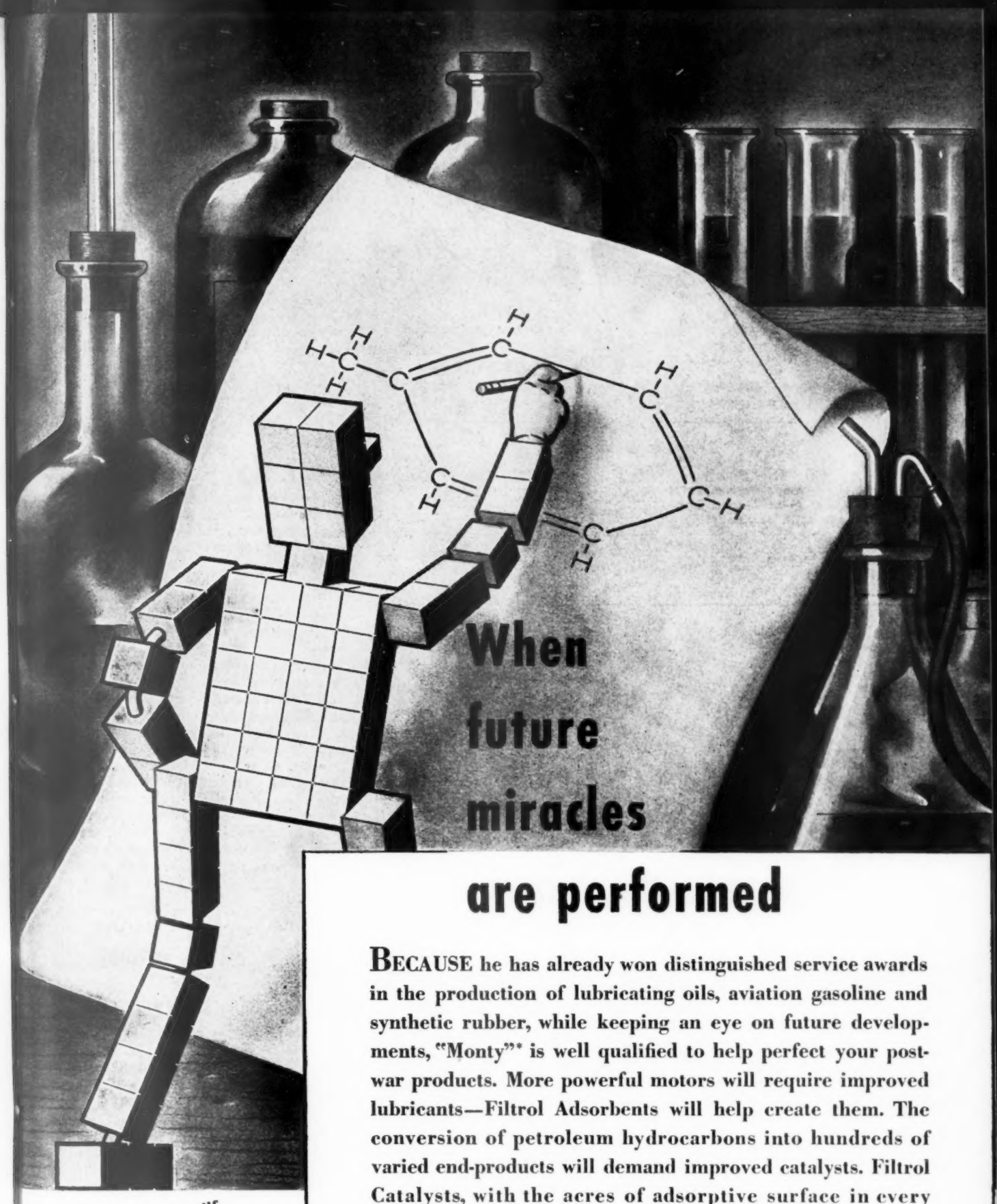
In tests with an L-head and a valve-in-head engine, an attempt was made at the outset to use a fuel that would satisfy both engine types with a minimum of excess antiknock quality. This was done by using a special gasoline blend. Nevertheless, as the borderline curves in Fig. 8 illustrate, the divergent knocking tendencies of these engines became apparent; that is to say, the valve-in-head engine knocked at low speeds and the L-head engine knocked at high speeds.

Thus, in order to satisfy both engine types, the over-all antiknock level of this fuel at both low and at high speeds would have to be raised. If the fuel were to be used in only one of the engine types, it is probable that either the high or the low speed performance could be improved by reblending the fuel. This, however, would result in a fuel that was more satisfactory for one engine but less satisfactory for the other.

Selected Fuels Used

A more composite picture of the effect of engine type on fuel antiknock quality was obtained by using test fuels with various tetraethyl lead concentrations. In these tests, a saturated type gasoline and a specially blended gasoline were used, each containing concentrations of tetraethyl lead ranging from 0.0 to 3.0 cc.

The resulting borderline knock curves are shown in Fig. 9 and Fig. 10. In each diagram, the heavy borderline



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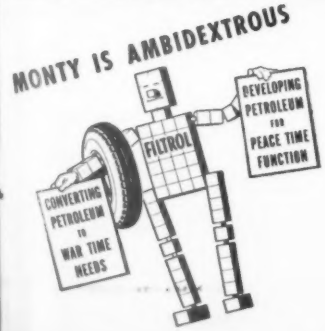

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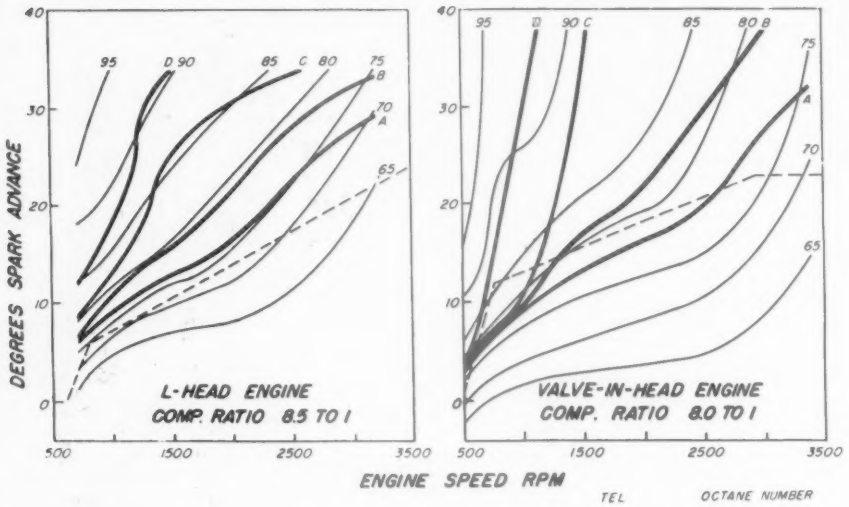
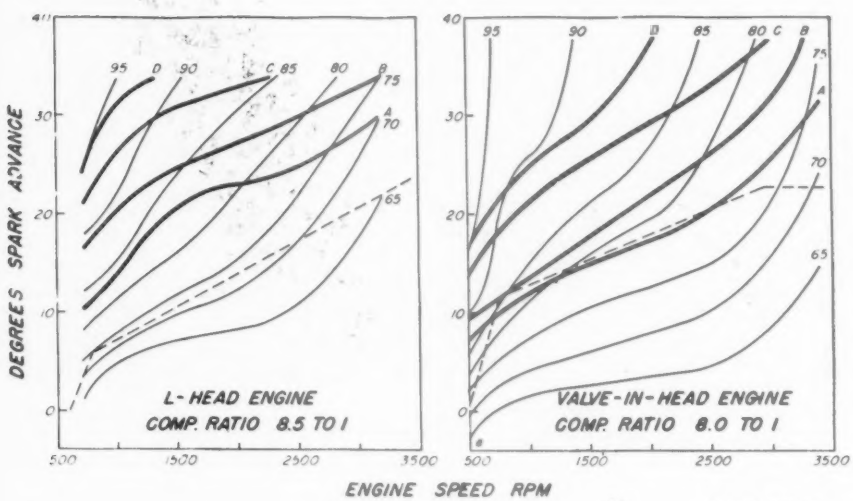


FUEL NO	TEL CC/GAL	OCTANE NUMBER MOTOR	RESEARCH
A	0.0	72.0	77.5
B	0.5	78.5	81.0
C	1.5	82.5	85.5
D	3.0	87.5	89.0

Fig. 9—Borderline knock curves, saturated type gasoline in L-head and valve-in-head engine



FUEL NO	TEL CC/GAL	OCTANE NUMBER MOTOR	RESEARCH
A	0.0	79.0	88.0
B	0.5	82.0	91.5
C	1.5	85.0	94.0
D	3.0	87.0	97.0

Fig. 10—Borderline knock curves, especially blended gasoline, in L-head and valve-in-head engine

curves A, B, C, and D are of the test fuels with various tetraethyl lead concentrations, as indicated. The light lines are the borderline curves for blends of reference fuels of varying ASTM octane number, indicated by the numbers 75, 80, etc.

In the case of the saturated type fuel the effect of engine type is quite noticeable. As an inspection of Fig. 9 reveals, an addition of 3 cc. of tetraethyl lead to this fuel permits a spark advance of only 5 degrees at 700 rpm in the valve-in-head engine, compared with an 8 degree spark advance in the L-head engine. On the other hand, the improvement at high speeds is more pronounced in the valve-in-head engine than in the L-head engine. In passing, it is interesting to note the similarity in shape between the borderline curves of the test fuel and the reference fuels. This is as expected since the secondary reference fuels (8) in common use are saturated type gasolines.

When borderline curves of secondary reference fuels are obtained in conjunction with curves of the test fuel, it is possible to obtain the octane value of the test fuel at any speed by interpolation and also to obtain the octane requirement of the engine throughout the speed range considered. This latter can be determined by noting the speed at which the borderline curves of the various reference fuel blends intersect the distributor-spark-advance curve. In this case, because of the similarity in type between the test and the reference fuels, there is little change in the octane value of the test fuels with speed. It should be noted, however, that the octane requirement of both test cars varies with speed, as shown in the following table:

L-HEAD ENGINE

Speed, rpm	Octane Requirement
1000	73
2000	72
3000	66

VALVE-IN-HEAD ENGINE

Speed, rpm	Octane Requirement
1000	83
2000	79
3000	75

The foregoing table indicates the general need for fuels having good low speed antiknock quality, since the antiknock requirements of an engine in terms of octane numbers are generally higher at low speeds than at high speeds.

From the shape of the reference fuel borderline curves, with respect to the distributor-spark-advance curves, it is apparent that a change in the basic spark advance will affect the octane requirement of both engines considerably more at low than at high speeds. (9) For this reason, a discussion of fuels based on octane numbers throughout the entire speed range is somewhat confusing and of little practical value to the vehicle operator. We believe, therefore, that a more usable conception of fuel antiknock quality is obtained by evaluating the test fuels in terms of allowable spark advance, inasmuch as adjustments in spark advance are generally the most practical means of obtaining knock-free operation with a given fuel.

Effect of Lead Concentration

Turning now to the tests with a specially blended gasoline, we see the effect that various concentrations of tetraethyl lead in this fuel have upon the allowable spark advance. This is shown in Fig. 10. The blended gasoline used is the same as that cited in Fig. 7.

As an inspection of Fig. 10 indicates, the borderline curves for this fuel, clear and with various tetraethyl lead additions, are not at all similar to the curves of the reference fuel blends. They represent a gasoline type that satisfies both engines remarkably well since the borderline curves tend to parallel the distributor-spark-advance curves. Yet, the basic difference in engines is still noticeable, the valve-in-head engine being more severe in low speed rating compared with the L-head engine.

This specially blended gasoline, moreover, has an excellent road tetraethyl lead susceptibility which permits a relatively great increase in spark advance at low speeds. In the case of Fuel D, con-

taining a concentration of 3 cc. of tetraethyl lead, a spark advance of 10 degrees at 700 rpm was made possible in the valve-in-head engine. This compares with a spark advance of only 5 degrees at the same speed in the same type engine, using a saturated type fuel. But once again, the difference in engines must be noticed. Against a spark advance of 10 degrees at 700 rpm in the valve-in-head engine, the addition of 3 cc. of tetraethyl lead permits a spark advance of 20 degrees in the L-head engine.

In evaluating the influence of engines upon the antiknock performance of gasoline, the effect of compression ratio must be considered. In this connection, to obtain a reasonable rating by the borderline method, the curve of the test fuel should not be displaced too far above or below the distributor spark advance curve. The effect of compression ratio is shown in Figs. 11, 12, and 13, in which a comparison between the saturated type gasoline and the specially blended gasoline is made at 3 different compression ratios, using the valve-in-head engine.

The borderline curves shown in Fig. 11 illustrate the effect of using fuels that are too good for an engine, or of using an engine whose antiknock requirement is too far below the antiknock value of the test fuels. In this case, a valve-in-head engine with a 6.5 compression ratio was used, and the contrast between the borderline curves and the distributor spark advance curves is obvious. Not indicated in this diagram is the relatively great difference in road antiknock quality between the two types of test fuels.

Effect of Compression Ratio

For a good comparison between these two test fuels, an engine compression ratio of 8.0 is about right. Such a comparison is shown in Fig. 12. There, it will be seen, the saturated type gasoline knocks slightly at low speeds, while its high speed characteristics are much better than necessary. To obtain knock-free operation using this saturated type gasoline, it is necessary to retard the basic timing by about 4 degrees. On the other hand, the blended gasoline does not knock at all and is satisfactory for this engine with the standard spark timing.

When these gasolines are rated in the same engine at a compression ratio of 9.0, the results shown in Fig. 13 are seen. Here, the antiknock quality of the saturated type fuel was so poor at speeds below 1500 rpm that it was impossible to obtain satisfactory ratings. The borderline curve for this fuel is estimated by the dotted extension of the curve in the speed range below 1500 rpm.

The blended gasoline, on the other hand, was rated satisfactorily throughout the entire speed range under consideration. This fuel does knock through a good portion of the speed range from 500 to 2200 rpm, but knock-free operation could be obtained by reducing the basic spark timing about 3 to 6 degrees. In the case of the saturated type gasoline, however, it would be necessary to reduce the basic spark timing about 10 to 15 degrees, to achieve the same result. This is obviously more than is practical.

In the previously described test with an engine of 9.0 compression ratio (see Fig. 13), the comparison between the unsaturated type and the blended gasoline involved two separate types of fuels which nevertheless had essentially the same ASTM method octane number. Yet, as the borderline curves in Fig. 13 indicate, the one gasoline is passable while the other is definitely unsuitable.

From this observation, it is interesting to speculate on the possible effect that a new type transmission would have on the fuel antiknock performance.

With the present type transmission, as shown, the blended gasoline is the type desired. However, if a new type transmission were used which would prevent "loading" the engine below 1500 rpm—in other words, if the engine were loaded in much the same manner as a propeller loads an aviation engine—the choice of fuel type would be quite different. With this new transmission, low speed anti-

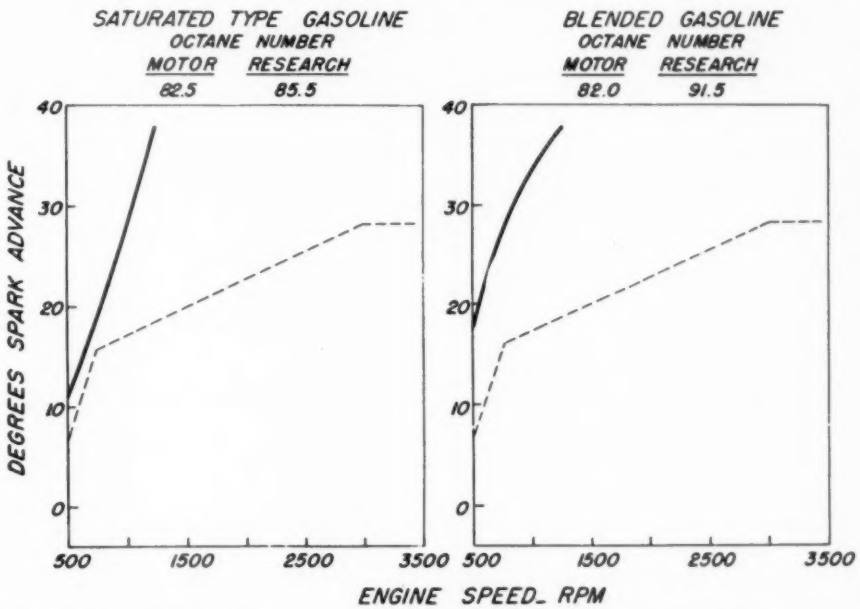


Fig. 11—Borderline knock curves for saturated type gasoline and blended gasoline in valve-in-head engine, at 6.5 compression ratio

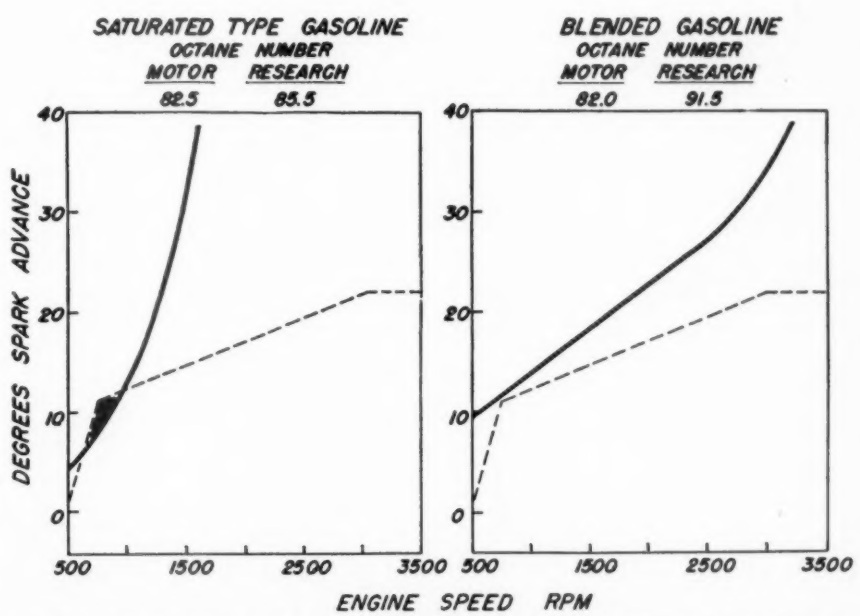


Fig. 12—Borderline knock curves for saturated type and blended gasoline in valve-in-head engine, at 8.0 compression ratio

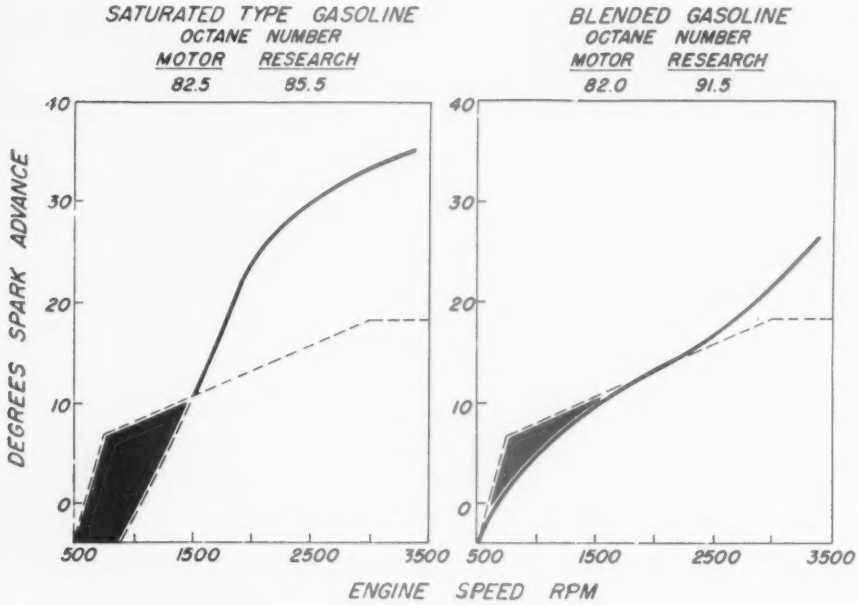


Fig. 13—Borderline knock curves for saturated type and blended gasolines in valve-in-head engine, at 9 compression ratio

knock quality would cease to be important, and the saturated type gasoline might be the preferable fuel.

We do not have data available to illustrate the possible effect of supercharging a small engine on the antiknock relationship between vehicle and fuel. It is reasonable to assume, however, that the laboratory octane numbers as now used may not give too reliable an idea of what to expect in the way of actual and usable antiknock quality.

Part IV—Laboratory Octane Ratings of Postwar Gasolines

In discussing motor gasoline antiknock quality—especially that of post-war gasolines—it must be emphasized again that laboratory octane numbers tell only part of the story. Besides octane number, the chemical composition of the fuel, the engine that will use the fuel, and the type of transmission used in the vehicle all will affect the antiknock quality of the gasoline on the road. Yet, laboratory octane number is the only yardstick we have at present, with which to estimate the post-war antiknock quality of gasoline, because there are, of course, no post-war cars in which to test the newer fuels.

Within these limitations, then, we can make some predictions about post-war antiknock quality of gasoline. In making any predictions, it is usually necessary to establish certain qualifying conditions. We are assuming, therefore, that the war will not end until the new refinery equipment now under construction will have been completed and, therefore, available for the production of post-war gasoline.

By projecting the past trends in the antiknock quality of motor gasoline, values of 83 ASTM octane number for premium fuel and of 79 ASTM octane number for regular grade fuel would be indicated in 1945. This is shown in Fig. 14. Such extrapolation, however, makes no allowance for the effect of the new wartime refining equipment.

As previously indicated if all excess post-war aviation gasoline were dumped into motor gasoline, it would result in an increase of only a few octane numbers. Further, this gain would be expensive. While the present wartime capacity of aviation gasoline is a military secret, it must be remembered that sizable quantities are required to affect the average of an industry which produces gasoline at the rate of 1,600,000 bbl. or 67,200,000 gal. daily.

Effect of Conversion

Instead, it is likely that much of the new refinery equipment will be converted to the production of motor gasoline components. Since this new equipment so far has been used only to make aviation fuel, it is necessary to estimate the effect this conversion will have on the national average of motor fuel antiknock quality. After considering the opinion of many oil company technologists, it is probable that the new wartime refining equipment, when used for making motor gasoline, will permit the production of gasolines with octane numbers for each of the several grades, as indicated in Table 3. For comparative purposes similar data on the octane number of average pre-war gasolines are also given. The table also shows the percentage of total production for each of the various grades of gasoline prior to the war and assigns upper and lower percentages that may be expected for each grade of gasoline.

Aviation fuel in the post-war period is expected to account for 6-8% of all gaso-

A view of one of the many natural gasoline absorption plants designed and constructed by Petroleum Engineering, Inc. in the past 15 years of continuous service to the industry . . . in design and construction of cycling plants, repressuring plants, vapor recovery plants and pure hydrocarbon plants. Petroleum Engineering, Inc. Offices: Tulsa, Houston.

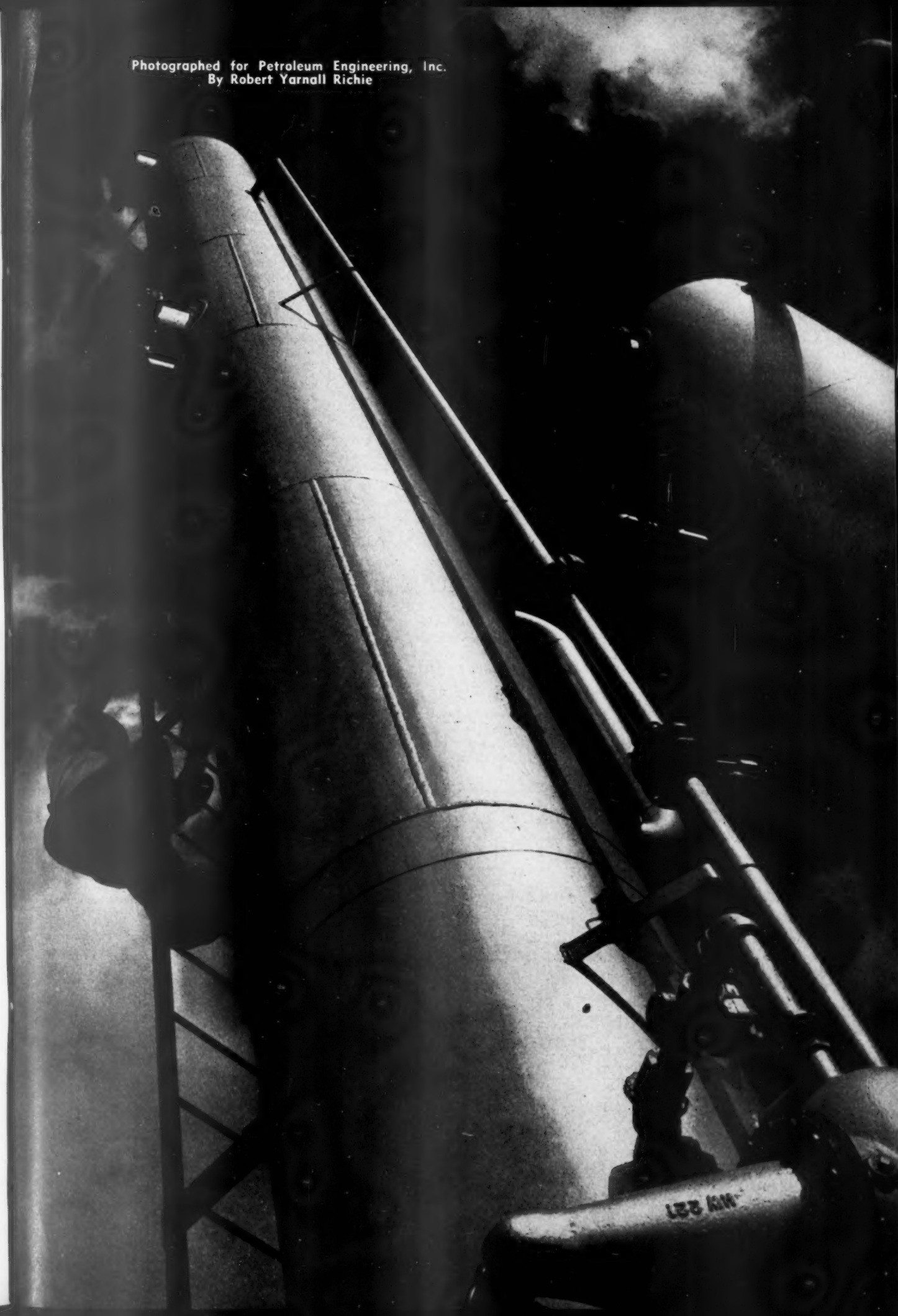

Photographed for Petroleum Engineering, Inc.
By Robert Yarnall Richie

TABLE 3—Estimated Proportionate Production of Postwar Gasolines by Grades, and Octane Numbers, Compared with Pre-War Production

(National Average)

POST-WAR

Grade	% Total Production	Octane Number Motor	Research
Aviation	6–8	100	.....
Premium	10–20	85–88	93–98
Regular	60–75	78–80	83–88
Third	5–15	68–70	70–74

PRE-WAR

Grade	% Total Production	Octane Number Motor	Research
Aviation	2	91–100	.....
Premium	10	80	86
Regular	78	75	80
Third	10	64	65

line produced, against only 1-2% before the war. This is about a fourfold increase and reflects the effects of wartime expansion on future aviation gasoline demands.

Opinions vary in regard to the amount of premium, regular, and third grades of gasoline that will be sold in the post-war period. A number of factors other than refining equipment that will be available must be considered in arriving at an estimate. Post-war prosperity, or the lack of it, for instance, will affect public demands for gasoline quality. Other factors that must be considered include the probable condition of engines in older cars and the antiknock requirements of new cars. Therefore, because of post-war uncertainties, the amount of premium grade gasoline sold may be anywhere between 10 and 20% of total production.

It is not likely, however, that the octane number of premium gasoline would be similarly affected. New engines designed to use the new premium gasoline will have a stabilizing influence on antiknock quality. In this connection, it is interesting to note that the octane number of post-war premium gasoline—estimated at 85 to 88 (ASTM Motor method)—is comparable in antiknock quality to the 87-octane aviation gasoline sold prior to the war. It is, therefore, conceivable that many of the post-war airplanes, estimated at 500,000* by 1950, will be designed to use premium grade motor fuel rather than a special aviation gasoline.

As to gasoline quality, the figures in the foregoing table indicate that regular grade motor fuel will be about as indicated by the extrapolation of past trends of ASTM Motor method octane numbers in Fig. 14, but that premium grade will be better than normally expected. In passing, it should be noted that the CFR Research octane ratings of post-war motor fuels (premium and regular) are expected to increase to a greater extent than the ASTM Motor method values. This increase in sensitivity or the relatively greater increase in CFR Research octane value results from the use of new equipment such as catalytic cracking, which produces fuels higher in aromatic content than usual thermal cracking processes.

It is our opinion that the increase in ASTM octane numbers, indicated in the foregoing table, is not altogether a true indication of the actual improvement in road antiknock quality. Using their new equipment and processes, the oil refiners will be able to control product type much better than before the war. This, combined with an increased knowledge of engine requirements, will allow the petroleum industry to produce gasoline blends which will perform considerably better than indicated by laboratory octane numbers.

*Estimated by the Civil Aeronautics Administration.

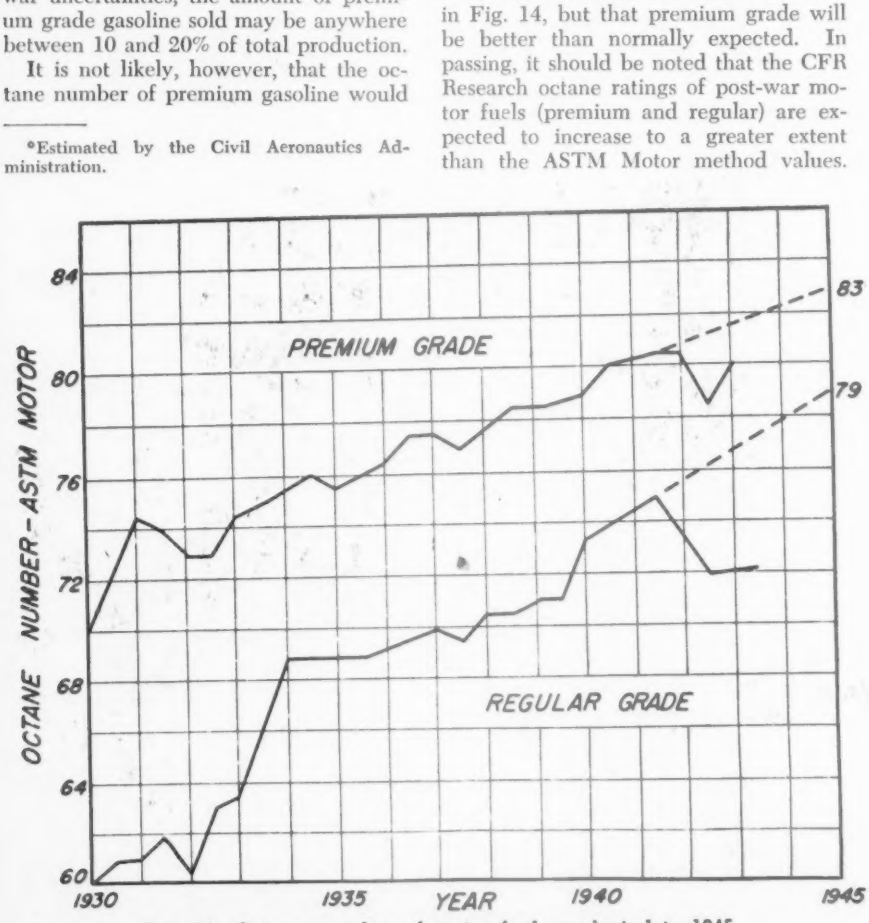


Fig. 14—Octane number of motor fuels projected to 1945

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A "highly sensitive" gasoline is generally considered to be one whose sensitivity is at least 8 octane numbers. An "insensitive" gasoline is one whose sensitivity is less than 3 octane numbers.

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Key Technologists in New Wartime Plants

Introducing some of the refinery technologists who have played an important part in the construction of the wartime 100-octane gasoline plants and who will now supervise their production of fighting grade aviation fuel.

Frontier Refining Wartime Plant in Cheyenne, Wyo.

THE 100-OCTANE aviation gasoline facilities of the Frontier Refining Co. at Cheyenne, Wyo., are now practically completed. The new facilities, which more than double the crude capacity of the existing plant, include: a fluid catalytic cracking unit, hydrogen fluoride alkylation unit, butane isomerization, thermal reforming and a gas concentration unit. The key technologists who will operate the new plant also had a prominent part in its construction.

A. A. Vendetti, process superintendent, is a native of Colorado, had his early schooling in Florence and graduated with a degree in chemistry from Colorado State Agricultural College. He is a veteran in refinery operation, having been with the old Midwest Refining Co., which later became Stanolind Oil & Gas Co., Sinclair Refining Co., the Old Dutch Refining Co. at Muskegon, Mich., Socony-Vacuum Oil Co. Inc. and the Bay Petroleum Corp. He was chief chemist and assistant superintendent at the Bay plant at McPherson, Kans., before starting last February on construction of the Frontier aviation gasoline plant.

D. W. Caswell will be process foreman of the new plant. He is a native of Texas and worked summers with the Simms Oil & Refining Co. of Dallas while attending Texas A. and M. College. After college he rejoined Simms, progressing through its laboratory, engineering and processing departments. In subsequent years he aided in the construction of the McMurrey Refining Co. plant at Arp, Texas, and the cracking unit of the Texas Oil Products Co. at Gladewater. In 1937 he went to Denver to help in the construction of the Bay Petroleum refinery there and remained as one of the operators when the plant opened. He had advanced to the position of chief chemist and light oils superintendent before resigning last May to join the construction personnel of the Frontier plant.

N. L. Deming, process foreman for the Frontier refinery, was born in Indiana but spent most of his youth in the east, attending Yale University. His college training was completed at Colorado School of Mines. He was in the engineering department of the Phillips Petroleum Co. plant at Borger, Texas, and a laboratory assistant in its Cody, Wyo., plant. He served as operator at the Independent Refining Co.'s plant at Laurel, Mont., and the Bay Petroleum refinery in Denver.

During construction of the Frontier plant he was engaged in the engineering department of the Fluor Corp., the construction contractors. His work in the new plant will center in the catalytic cracking unit, and gas concentration and crude reforming units.

Pan American Refining Aviation Gasoline Plant

Pan-American Refining Corp. did not set up a separate operating unit for its aviation gasoline plant at Texas City, Texas, according to P. J. Sweeny, manager. The alkylation unit was added to the treating division, under the supervision of B. F. Babin, and the fluid catalyst cracking unit to the catalytic and distillation division under J. B. Hamblen. These men are under the direction of the assistant general superintendent, in charge of process, Dr. H. R. Snow.

Facilities for increased steam and power production were added to the utilities division under B. E. Abercrombie, and the technical work of a chemical or engineering nature was placed with the present laboratory staff, under R. H. Price, director of research.

N. L. Deming

A. A. Vendetti

D. W. Caswell

Socony-Vacuum Oil Co.'s East St. Louis Plant

W. H. Montgomery

NEW facilities for the production of aviation gasoline at the East St. Louis refinery of the Lubrite Division of Socony-Vacuum Oil Co. are expected to go into production in the next few weeks. The refinery has been blending 100-octane gasoline from catalytic base stock for some time. However, with the completion of new facilities including a Thermofor Catalytic Cracking unit and a hydrogen fluoride alkylation plant, increased quantities of base stock and alkylates will be available for blending.

W. H. Montgomery, who is manager of the East St. Louis refinery, was formerly assistant manager of the Standard Vacuum Oil Co. refinery at Palembang, Sumatra, Dutch East Indies. D. A. Windsor, who is general superintendent, has been in direct charge of the plant for the past 20 years. J. B. Hickey is operating superintendent and D. P. Parker assistant operating superintendent. These last two will be in direct charge of the operation of the new aviation gasoline facilities. They also have advanced through the Lubrite organization.

J. A. Jamison, who was formerly with M. W. Kellogg Co., is now manager of the process control department at East St. Louis and will have charge of the technical control of the new units.

The Development of the Hydrogen Fluoride Alkylation Process*

New problems were raised for refinery technologists in the use of anhydrous hydrogen fluoride as a catalyst in the alkylation process. These were accentuated through much of the development work being done under emergency wartime conditions. The problems resulting from the unusual properties of hydrogen fluoride have to do with its behavior toward materials of construction, its physiological effects and the chemical reactions occurring under alkylating conditions. Much larger scale usage of this agent is involved than had previously been encountered, single commercial units containing as much as 20,000 gals. of hydrogen fluoride and circulating streams containing as much as 300,000 gallons of it per minute. The means by which many of these problems were overcome in the development and commercial stage is discussed.

*By C. G. Gerhold,** J. O. Iverson,**
H. J. Nebeck,** and R. J. Newman***

THE paraffin alkylation reaction, which is the interaction of isoparaffin and olefin hydrocarbons to produce highly branched paraffinic motor fuels, was discovered by V. N. Ipatieff and Herman Pines more than a decade ago at the Research and Development Laboratories of Universal Oil Products Co.

Since the time of this fundamental discovery, extensive laboratory and pilot-plant experimentation has been carried on to study the reaction with several catalysts.[1, 2, 3] Investigations by Carl B. Linn and A. V. Grosse indicated that concentrated HF was an excellent catalyst for alkylating isobutane with propylene, butylene, or amylenes. The olefins were completely converted in the presence of an excess of isoparaffin to give a saturated product with excellent anti-knock properties boiling almost entirely in the aviation gasoline range.

Although the catalytic properties of HF were attractive, the commercialization of the process was delayed, largely because of the nature of HF and the lack of experience in handling it in the manner and quantities required for hydrocarbon processing. When it became apparent that the facilities for the production of aviation gasoline would have to be expanded to supply the war needs, the development of the HF process was rapidly accelerated. Pilot-plant tests for the investigation of charging stocks, operating conditions, and materials of construction, and process and mechanical designs of commercial plants that normally would have required years, were forced through in a matter of months.

Two major advantages of HF alkylation over the older sulfuric acid process are the higher process temperature and the ease of catalyst regeneration. The higher temperature permits use of cooling water to remove the heat of reaction and thus eliminates critical refrigerating equipment. Catalyst regeneration is an inherent feature of the process: Catalyst consumption is so low that the raw material and plant requirements for catalyst manufacture are considerably smaller than those for a sulfuric acid alkylation unit on the basis of equal alkylate production. Elimination of the problem of spent catalyst disposal, which is serious in many refineries using sulfuric acid alkylation, is a further advantage gained by catalyst regeneration.

Properties of Hydrogen Fluoride

Many chemical engineers remember hydrofluoric acid as an extremely corrosive material kept in a wax bottle in a school storeroom and used for classroom demonstrations of glass etching; and they were probably warned of the dangerous nature of the material. Fortunately the concentrated hydrogen fluoride used in the alkylation process is not corrosive to steel. While it is extremely corrosive to the skin, prompt and proper treatment stops the action immediately and prevents painful destruction of tissue.

Anhydrous hydrogen fluoride boils at 67° F. and has a specific gravity of 1.00 at 32° F. and a viscosity approximately equal to that of water. It is slightly soluble in paraffin hydrocarbons and is miscible with water. HF is a powerful dehydrating agent, which cannot be dried by ordinary chemical means. It forms a maximum boiling solution with water that contains approximately 37% HF. The catalytic and physical properties of HF have been described in a recent article.[4]

Hydrogen fluoride is prepared by treating fluorspar with concentrated sulfuric acid in steel equipment at temperatures ranging from 300° to 400° F. The equipment of the manufacturing plant is made of steel. Solutions containing not more than 40% water are shipped in steel containers or tank cars. The available supplies of HF before the war were not sufficient to meet the requirements of this process, and it was necessary to expand existing manufacturing facilities.

Hazards In Handling HF

Hydrogen fluoride must be regarded as a potentially hazardous material, but years of experience in the manufacture of HF in large quantities without a disproportionate share of accidents are proof that the material can be handled safely. Many devices were developed and incorporated into the design for protecting the operating personnel. Accidents, however, may occur in any plant in spite of the most rigid safety regulations and the best of safety devices. In view of this fact an exhaustive study was made of the methods of handling HF and the treatment of HF burns.

Concentrated HF has a triple action on contact with the skin in that it has a dehydrating effect, it acts as an acid, and it catalyzes the destruction of tissue, causing deep, slow-healing burns. First-aid and medical treatment of burns in general are directed toward removal and neutralization of the acid and precipitation of the fluorine as an insoluble salt. Before the development of this alkylation process, the use of anhydrous HF was limited and HF burns were uncommon; moreover, some of the methods for treating an ordinary burn were entirely unsuitable for HF injuries. Therefore, the latest medical information on the treatment of HF burns was supplied by U.O.P. in the form of a book by A. J. Carlson[5] to the doctors in the vicinity of the plants.

Process Flow of HF Alkylation

The flow of a typical HF alkylation unit is shown in Fig. 1. Charging stock to the plant passes through charge pretreaters which remove organic impurities and water that would otherwise contaminate the products or catalyst. After pretreatment the charge is combined with recycle isobutane and fed to the reaction system. The reaction is carried out in contactors equipped with efficient mixing devices, which maintain contact between the hydrocarbon and catalyst phases and with cooling coils which remove the heat of reaction. The

*Presented before the annual meeting of the American Institute of Chemical Engineers, Pittsburgh, Nov. 14-16, 1943; published in the Dec. 25, 1943, Transactions of the Institute, Vol. 39, No. 6.

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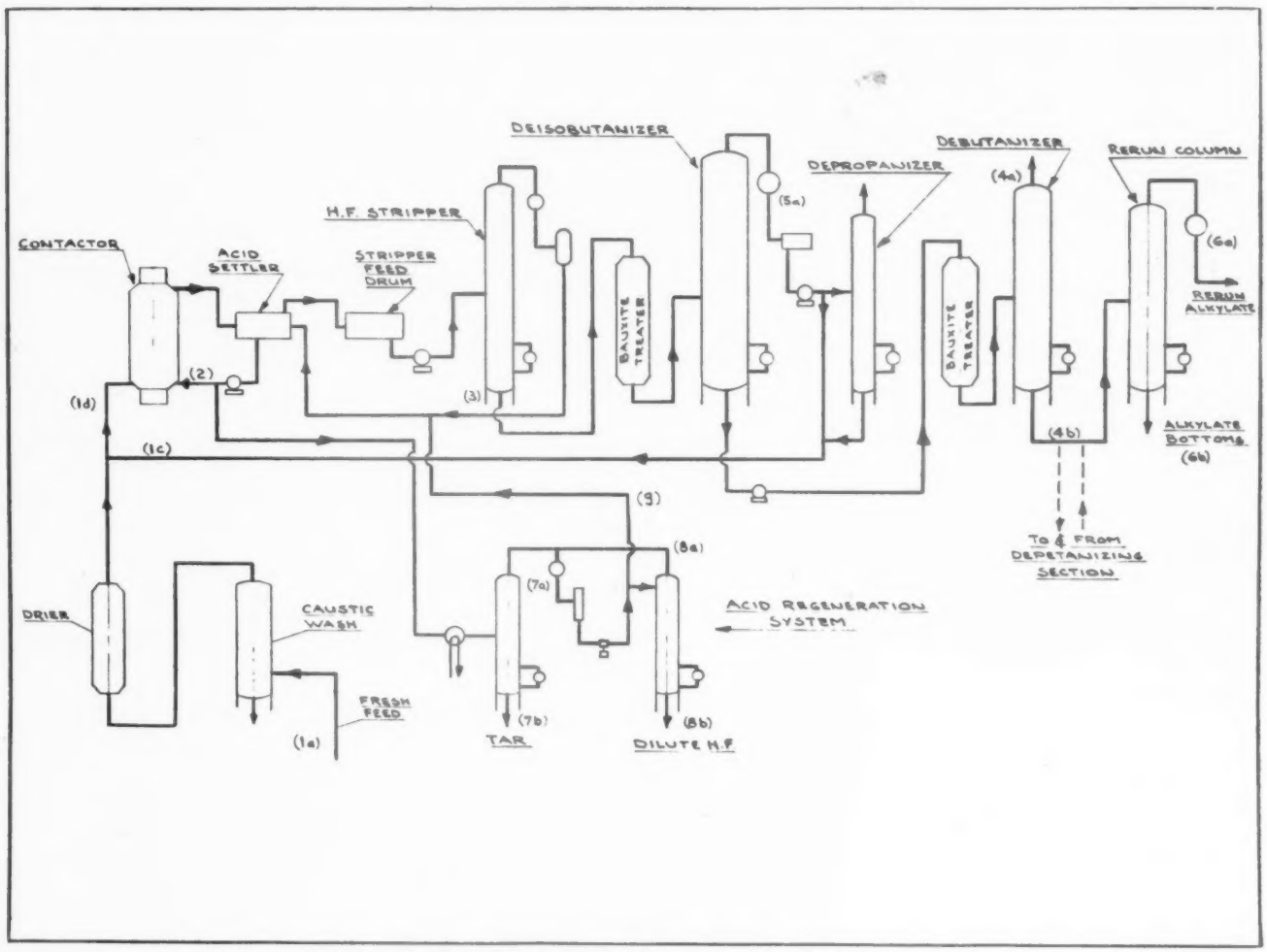

Fig. 1—Flow sheet of typical hydrogen fluoride alkylation unit

effluent from the contactors passes to a settler in which separation of the catalyst from hydrocarbon is made, the catalyst being returned to the reaction vessel and the hydrocarbon being fed to the fractionation system.

The hydrocarbon stream leaving the settler contains a small amount of dissolved hydrogen fluoride and some organic fluorides. The first fractionation column strips the hydrocarbons of hydrogen fluoride, which is returned to the reaction zone.

The bottoms from the stripper are fed to a treating section, in which fluorides are broken down and the liberated HF removed. The effluent from this treater is fed to a deisobutanizer, in which the isobutane is separated from the other hydrocarbons. This separation is necessary because a satisfactory alkylation operation requires high isobutane concentration in the contactor. This high concentration is obtained by recycling isobutane.

Bottoms from the deisobutanizer are charged to a debutanizer, where normal butane is removed as overhead. The aviation alkylate is distilled from the debutanized total alkylate in the final fractionation step.

Some propane is always present in the charge to an alkylation plant, and it must be removed from the system. In the case of alkylation operations in which the amount of propane is small, it is removed by depropanizing a portion of the recycle isobutane as shown in the flow diagram. When propane makes up a substantial portion of the feed, combined depropanizing and HF stripping of the reactor effluent are carried out in a stripper of modified design.

Units for alkylating with amylenes have, in addition to the equipment shown, two fractionation columns for the recovery of high octane number isopentane and the elimination of low octane number normal pentane.

As a result of side reactions, hydrocarbons of high molecular weight and low hydrogen content accumulate in the catalyst phase. In order that the activity may be kept at the desired level, these hydrocarbons are removed in a regenerating distillation step, in which the tars are taken out as bottoms and purified HF is removed as overhead. Accumulation of water in the catalyst phase is prevented by a second regeneration step, in which a part of the overhead from the first step is redistilled to remove water in the form of a constant-boiling mixture containing about 37% HF. Regenerated catalyst is returned to the reaction zone.

Pilot-Plant Investigations

The pilot-plant investigation of the process, which has consisted of more than 300 test runs on 5 different pilot plants, has been underway for several years. The scope of the work has included the development of satisfactory equipment, the investigation of process variables and charging stocks, and the solution of specific commercial design problems.

Because of the war it was necessary to begin the design and construction of commercial units before a comprehensive pilot-plant program could be completed. Consequently, most of the early part of the pilot-plant program was devoted to the solution of design problems.

Pilot-Plant Equipment

The results of the early pilot-plant tests in a plant that consisted essentially of a charge pump, a steel bomb equipped with a paddle mixer, a settler, a caustic scrubber for neutralizing dissolved HF, and a debutanizer were enough to warrant further work. The next part of the program was devoted to the improvement of the pilot plant. One of the

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major problems in this connection was the development of a satisfactory contacting device. The contactor had to be so designed that thorough mixing of the hydrocarbon and HF phases could be obtained in a plant of a size corresponding to the limited supply of charging stock. It was found that a steel vessel fitted with a packed-shaft double impeller would best meet the requirements.

One of the difficulties encountered with this mixer was the deterioration of the shaft packing through contact with the HF. This difficulty was overcome by passing the stirrer shaft through the top of the reactor, by lubricating the packing, and by bringing all of the hydrocarbon charge into the annular space around the shaft just below the packing, where it served as a protective flush. With this arrangement, runs of more than 30 days were made without packing failure.

Later in the pilot-plant program a unit was constructed which included a Stratco contactor built on pilot-plant scale. The first few runs showed that the conventional mechanical seal, flushed with charging stock, similar to that used on commercial contactors was not suitable for work on a pilot-plant scale. The packing in the seal failed because the volume of charging stock was not sufficient to flush the HF away from the seal. This failure resulted in the leakage into the reactor of a large amount of the lubricating oil which held the faces of the seal together. This leakage was objectionable in that it resulted in contamination of the product. A modified type of seal was developed that reduced the seal oil leakage to between 1 and 2 cc/hr. over an extended period of time.

Problems in Process Design

Three of the major problems in connection with plant process design that had to be solved on the pilot plants dealt with the recovery of dissolved acid in the alkylation products, the defluorination of the alkylation products, and the regeneration of used acid.

The importance of recovering the HF dissolved in the hydrocarbon stream leaving the catalyst settler is shown by the fact that the value of this dissolved HF amounts to about 3c a gallon of alkylate for a plant operating under the usual commercial conditions. Since HF and hydrocarbons are relatively immiscible and the HF is fairly volatile, it appeared that dissolved HF could be removed by fractionation from lower boiling hydrocarbons in a manner analogous to that used for the removal of dissolved water from light hydrocarbons.

In this type of separation the inorganic solute is driven upward in a countercurrent stripping column, and taken overhead in admixture with hydrocarbon solvent in sufficient concentration that the liquid resulting from condensation separates into two phases, the solvent phase being returned to the column. This system may be used in any separation of relatively immiscible liquids if the Henry's law constant of the solute is higher than the corresponding value for the solvent.

Approximately correct values of these constants may be readily determined from vapor pressure data for the pure components and solubility data, by consideration of a three-phase system at saturation. The partial pressure of each component from either liquid phase in such a system must be equal to that from the other liquid phase. In each case the partial pressure may be calculated by application of Raoult's law to the phase in which the component predominates.

Application of partial pressure data, determined by the above calculation, together with solubility data, to the phase which is predominantly hydrocarbon in a saturated isobutane-HF system indicates a Henry's law constant for the HF approximately 10 times as high as that for isobutane.

In view of the indication from this calculation that such a means of separation would be operable, a stripping column based on this principle was constructed and installed in the pilot plant. Tests on this column demonstrated that the HF could be stripped easily from the settler effluent.

Because the presence of combined fluorine in the products of alkylation is objectionable, a method of removal had to be developed. Preliminary testing of many defluorinating agents in the laboratory was followed by more extensive testing of the promising materials on the pilot plants. The data sought were the life of the defluorinating agent and the relationship between space velocity, temperature, and per cent of defluorination. As a result of this work it was decided that bauxite should be used as the defluorinating material in the first commercial units.

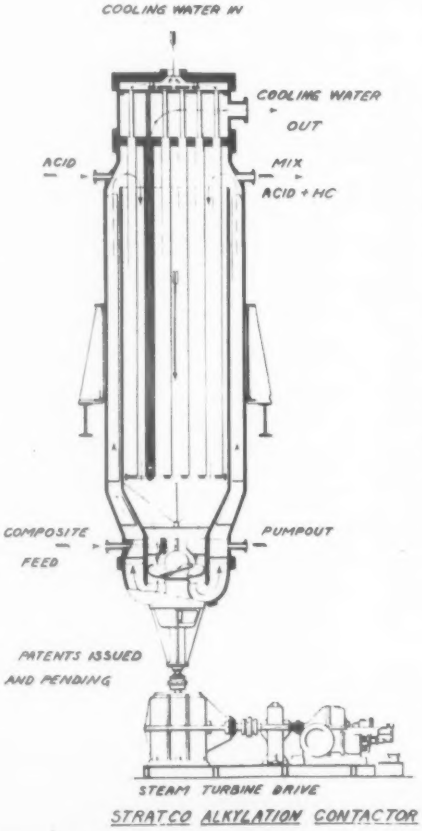

Fig. 2—Stratco alkylation contactor for HF alkylation process

Although bauxite was sufficiently good to warrant its incorporation in the early plants, it had certain disadvantages. One of these was that it combined with the fluorine which it removed from the alkylation products, so that it caused appreciable HF consumption. Another disadvantage was the necessity for the periodic replacement and disposal of the spent bauxite. A better defluorinating agent has been found, however, which catalytically decomposes the alkyl fluorides into HF and olefins. This new catalyst will be used in such a manner that the liberated HF will be returned to the reaction zone. Thus, its use will reduce HF consumption and eliminate an operating inconvenience.

One of the distinct features of the HF alkylation process is the ease with which the tarry material that gradually accumulates in the catalyst phase may be removed. A method of regeneration was first discovered in the laboratories, where it was found that simple distillation restored the activity of used catalyst. Pilot-plant work in connection with acid regeneration was primarily directed towards obtaining design data.

Studies of Process Variables

A considerable amount of data with respect to the effects of the feed-stock composition and process variables was obtained during the early part of the pilot-plant program. The olefins that were investigated for alkylating isobutane included various butylenes, propylene, amylenes, polymers, gasoline fractions, and mixtures of the foregoing olefin hydrocarbons. The effects of impurities, such as butadiene, sulfur, and water, were studied. Tests also were made in which isopentane was used as the isoparaffin. Operating variables, including the isoparaffin-olefin ratio, catalyst activity, space velocities, temperature, and degree of mixing, were studied to determine their effects upon the yield of aviation alkylate, octane number, HF consumption, and regeneration requirements. These investigations are still under way.

Chemistry of Alkylation Process

Much of the experimental work was directed toward developing the chemistry of the process with a view to orienting the further pilot-plant work and commercial plant design. The reactions involved were found to be complex, since HF is a catalyst for a variety of different reactions. It can be shown that little or no reaction takes place in the hydrocar-

bon phase, since for a given feed rate relative to catalyst volume, changing the hydrocarbon residence time does not appreciably alter the over-all results. The olefins apparently combine rapidly with the hydrogen fluoride and remain in the catalyst phase until converted into some other material through chemical reaction. Isoparaffins are slightly soluble in HF. The paraffinic products of reaction are also of limited solubility and may be readily extracted from the catalyst phase by contact with a hydrocarbon stream.

The principal reactions occurring in the reaction zone are apparently as follows:

(1) Direct interaction of an olefin and an isoparaffin, either of which may be charged as such or may be the result of previous reactions.

(2) De-alkylation of paraffins of high molecular weight.

(3) Polymerization of olefins to form olefins of higher molecular weight.

(4) Depolymerization reactions.

(5) Hydrogen transfer reactions between olefins to form saturated hydrocarbons and tars of low hydrogen content.

(6) Hydrogen transfer reactions between paraffins and olefins to form a paraffin corresponding to the olefin and an olefin corresponding to the paraffin.

(7) Isomerization reactions, particularly of the alkylate product.

A number of reactions take place, and a variety of products may be made by changing the balance of these reactions. The most desirable products are those of the direct combination of the olefin and the isoparaffin feeds, and conditions should be so chosen as to favor such a reaction within the limits of commercial practicability. The means of adjusting the balance between reactions lies in the control of the concentrations of the various reactants and reaction products.

The undesirable reactions between olefins may be minimized by maintaining a low concentration of organic fluorides in the catalyst phase; this condition may be brought about by the use of a large catalyst pool relative to the charge rate. Therefore, units should be designed and operated to maintain a relatively large volume of catalyst in the reaction zone.

The desired reaction of primary alkylation is favored by increasing the concentration of isobutane in the catalyst phase. This effect can be brought about by recycling isobutane and thus increasing the concentration of isobutane in the hydrocarbon phase. Because the catalyst and hydrocarbon phases are in substantial equilibrium, the percentage of isobutane in the catalyst phase depends upon that in the hydrocarbon phase.

The recycling of isobutane is also favorable from the standpoint of removing the primary reaction products rapidly and preventing further reaction of these materials, since the recycling of isobutane in this manner lowers the concentration of alkylate in the hydrocarbon phase and therefore lowers the concentration in the catalyst phase.

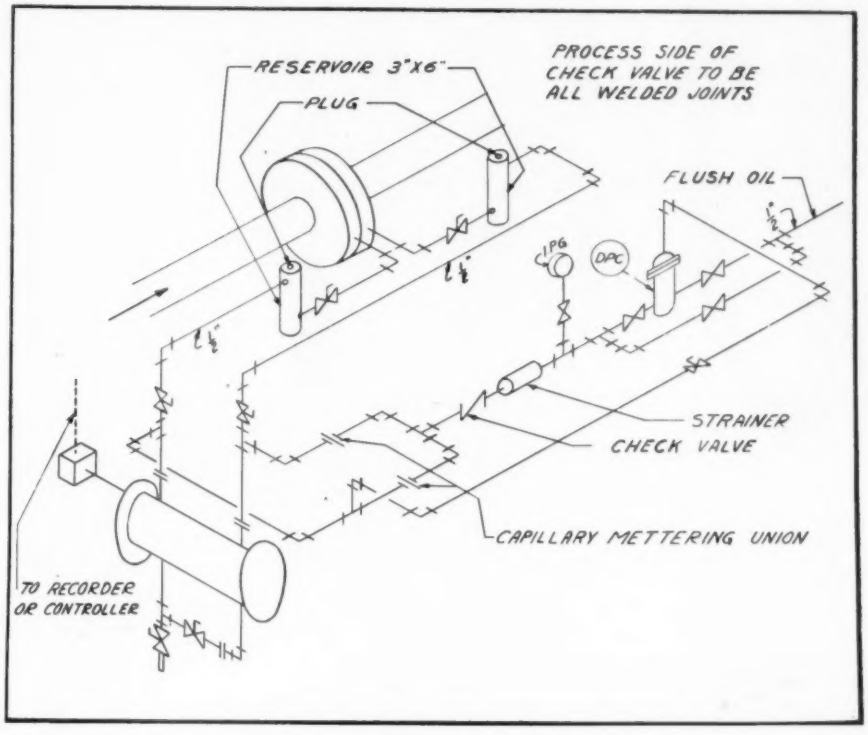

Fig. 3—Typical HF hydrocarbon flow meter installation

The reaction is also influenced by the intimacy of contact between phases. The reaction tends to decrease the concentration of isobutane in the catalyst phase below that corresponding to physical equilibrium with the hydrocarbon phase, and to increase the concentration of the alkylate in the catalyst phase above that corresponding to physical equilibrium with the hydrocarbon phase. The more intimate the contact between the two phases, the more nearly is physical equilibrium approached and the cleaner is the reaction.

Another process variable which has been found to be useful in controlling the reaction is the concentration of HF in the catalyst phase. Tars from hydrogen transfer reactions accumulate in the catalyst phase until removed by distillation. These tars alter both the solubility and the reaction characteristics of the catalyst; therefore, the amount of such materials has an influence on the type of reaction obtained. It has been determined experimentally that there is an optimum concentration of these materials.

Temperature has been found to have little effect on the direction of the reaction in the range normally encountered.

Pressure under which the reaction occurs should be sufficient to maintain the reactants and catalyst in the liquid phase.

A small portion of the total organic fluorides present in the reaction system at any time is in the hydrocarbon phase and is carried out of the reaction system with the hydrocarbons. It is desirable to employ operating conditions such that the amount of this material in the hydrocarbon phase is kept at a minimum in order to conserve HF. Since the amount in the hydrocarbon phase is a function of the concentration in the catalyst phase, it follows that conditions which prevent the interaction between olefins, such as a relatively large catalyst pool, also minimize the loss of organic fluorides. It has also been found that the concentration of organic fluorides may be kept low by maintaining a relatively high concentration of HF in the catalyst phase.

Testing of Material and Equipment

Many materials were tested statically in the laboratory for resistance to corrosion both in anhydrous HF and in a constant-boiling mixture of HF and water. The more promising materials were tested dynamically in commercial equipment in which a mixture of equal portions of anhydrous HF and butanes was circulated by means of a standard single-stage overhanging-type centrifugal pump through a system containing various type of valves, flow meters, control valves, and other equipment. Satisfactory available materials were found for various services.

Extensive experimental work on packings for pumps and valves, lubricants for plug cocks, substitutes for conventional gauge glasses, and many other mechanical features and techniques was necessary in order to obtain the engineering

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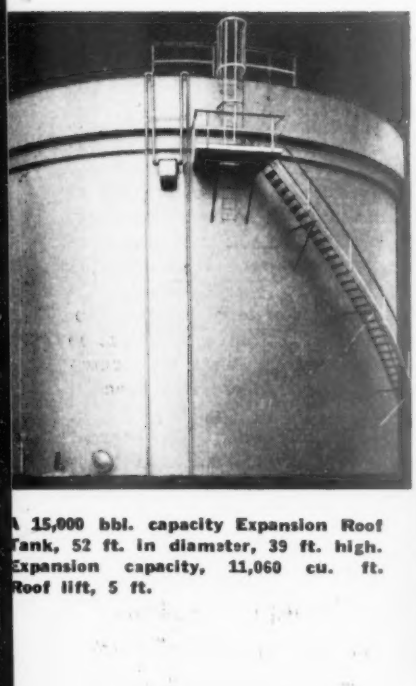
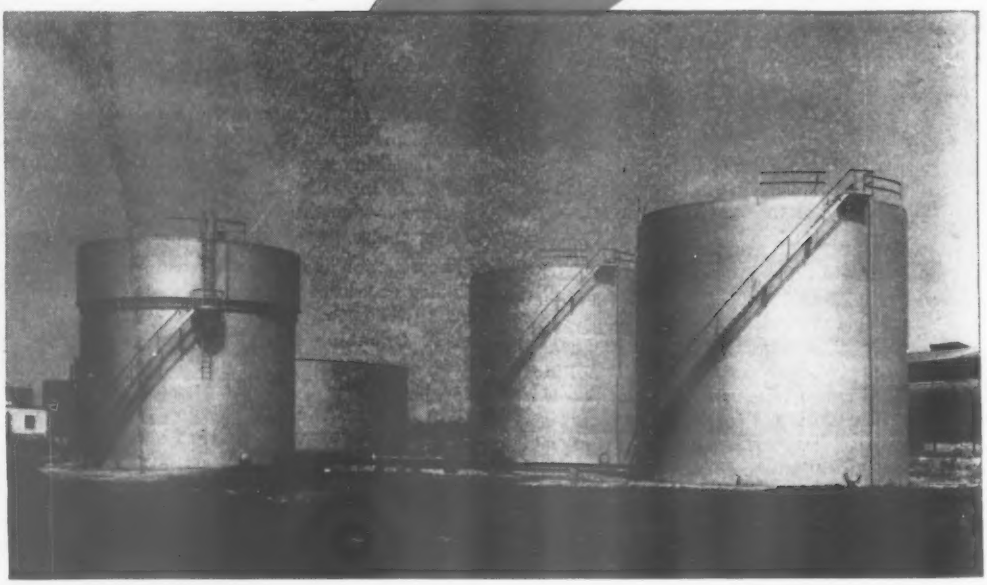


A 15,000 bbl. capacity Expansion Roof Tank, 52 ft. in diameter, 39 ft. high. Expansion capacity, 11,060 cu. ft. Roof lift, 5 ft.



A 10,000 bbl. Graver Expansion Roof Tank with a 14,100 cu. ft. expansion capacity. 42 ft. high with a roof lift of 10 ft. It is manifolded to several cone roof tanks providing expansion capacity for the entire group.

GRAVER

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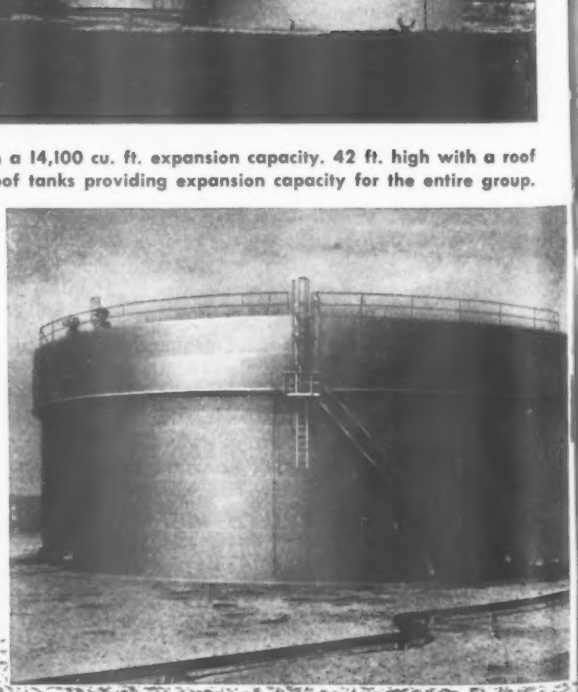
A 120 ft. diameter Graver Expansion Roof Tank. Capacity, 80,000 bbls. Expansion capacity, 114,200 cu. ft. Roof lift, 10 ft.

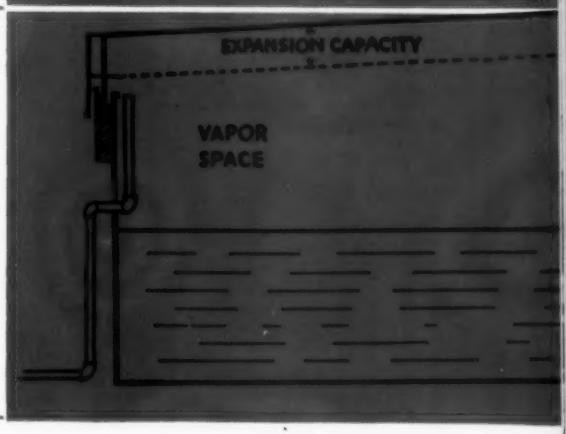


NO VAPOR LOSSES

GRAVER EXPANSION ROOF

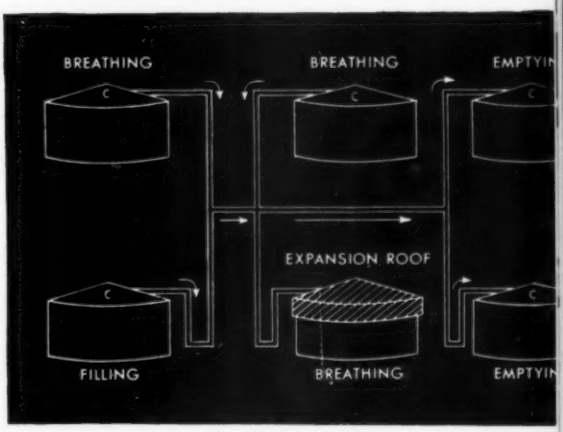
● The Graver Expansion Roof is designed to provide a variable vapor space so as to hold the vapors within the tank at all times, regardless of temperature variations. This diagram shows a Graver Expansion Roof tank half filled and with a low vapor space temperature. Under this condition the roof is at a low position.

● However, if the temperature rises, the expanding vapors must be taken care of. This diagram shows the relative position of the Expansion Roof under these conditions. Instead of permitting the expanding vapors to be forced out, the Expansion Roof rises due to the pressure created by these vapors, providing ample space. Being oil sealed, no vapors can escape.



. . . AND . . . FOR MULTIPLE SAVINGS

● The vapor spaces of several cone roof tanks can be manifolded to the vapor space of a single Graver Expansion Roof tank of suitable size. In this way, complete protection is afforded to an entire battery with but one Expansion Roof installation. This method of manifolding applies with equal efficiency to both refinery units and terminal operations.



At refineries and pipe line terminals of many of the country's major oil companies, Graver Expansion Roofs are demonstrating their ability to pay for themselves through actual savings in gallonage as well as in maintaining quality of product.

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information required for the design of a commercial plant.

Features in Mechanical Design

Previous to the development of the HF alkylation process there had been no installation in which anhydrous HF had been pumped in large quantities. Small pumps had been used for loading and unloading tank cars; but losses due to leaks were relatively high, and the life of the pumps was short. The proposed designs in some cases involved the circulation in the reactor systems of quantities up to 300,000 gpm and the pumping of external catalyst streams up to 900 gpm into reactor systems containing approximately 20,000 gallons of HF.

Leaks could not be tolerated in a large plant because of the hazards involved and the value of the material. Since concentrated HF attacks pump packings, it was necessary to make special provision for a leakproof pumping system. Many similar changes from standard designs for hydrocarbon and chemical manufacture were required in instruments, valves, piping, and other parts of the plant. Because of wartime conditions, it was necessary to adopt, as far as possible, standard equipment with a minimum of modification. Means of combating contamination of the atmosphere and pollution of surface water was a special problem that had to be solved.

Reactor Equipment

Three basic requirements had to be met by the equipment in the reaction zone. It had to provide intimate contact between phases, ample volume to maintain a satisfactory reaction time, and means for removing the heat of reaction. Standard Stratco contactors with built-in cooling bundles were selected, and only slight modification was necessary to meet these requirements. These contactors, one of which is shown in Fig. 2, are built of rolled carbon steel flanges and shell with cast steel bottom heads and mixing impellers. The contactor most commonly used has a volume of 4900 gallons and an impeller driven by a 250 hp unit. Leakage along the impeller shaft is prevented by a mechanical seal.

Satisfactory methods of pumping and metering the catalyst phase had to be developed in connection with the investigations concerning regeneration, because the quantities handled were below the practical range of a centrifugal pump.

A mercury surge pump was developed for this service. A conventional plunger type of pump is connected through a "U" bend to ball check valves. Mercury is placed in the "U" bend, and a light oil is maintained between the mercury and the plunger of the pump. The HF in the opposite leg is moved by the mercury. A commercial lubricator is connected to the driving mechanism of the pump and continuously injects a small amount of oil to offset leakage.

Instruments

The problems of the design engineer were simplified somewhat by recent developments in instruments, such as wide-range level controls, torque-tube transmission, aneroid differential instruments, and remote electric flow meters. Such instruments have made possible the measurement, recording and controlling of flows and levels in HF service without the possibility of leakage that might be expected through conventional stuffing boxes. Hardened carbon steel parts were substituted for the critical alloys usually employed for trim.

Because the solubility of HF in the hydrocarbon varies with temperature, meter lines were purged to avoid precipitation which might be caused by change in temperature. An exhauster connection was also provided to facilitate preparing the instrument for removal from service. Fig. 3 illustrates a typical HF hydrocarbon flow meter installation.

Standard pressure gauges were modified for HF service by incorporating a seamless steel bourdon tube welded or silver brazed at the tip and in the socket.

Skin-type thermocouples were used for temperature indication to minimize connections into equipment containing HF. Fig. 4 illustrates a typical skin couple.

For reasons of safety all instruments that contained HF were mounted locally, and either air or electricity was employed for transmission to, or remote control from, the main instrument board.

Pressure-Relief Systems

A closed relief system, through which all relief valves in HF service discharge, carries the vapors to a remote scrubber where they are neutralized before venting. The relief valves in HF service have special trim and are protected by a corrosion-resisting rupture disc. Fig. 5 illustrates a typical relief valve installation. The connection between the

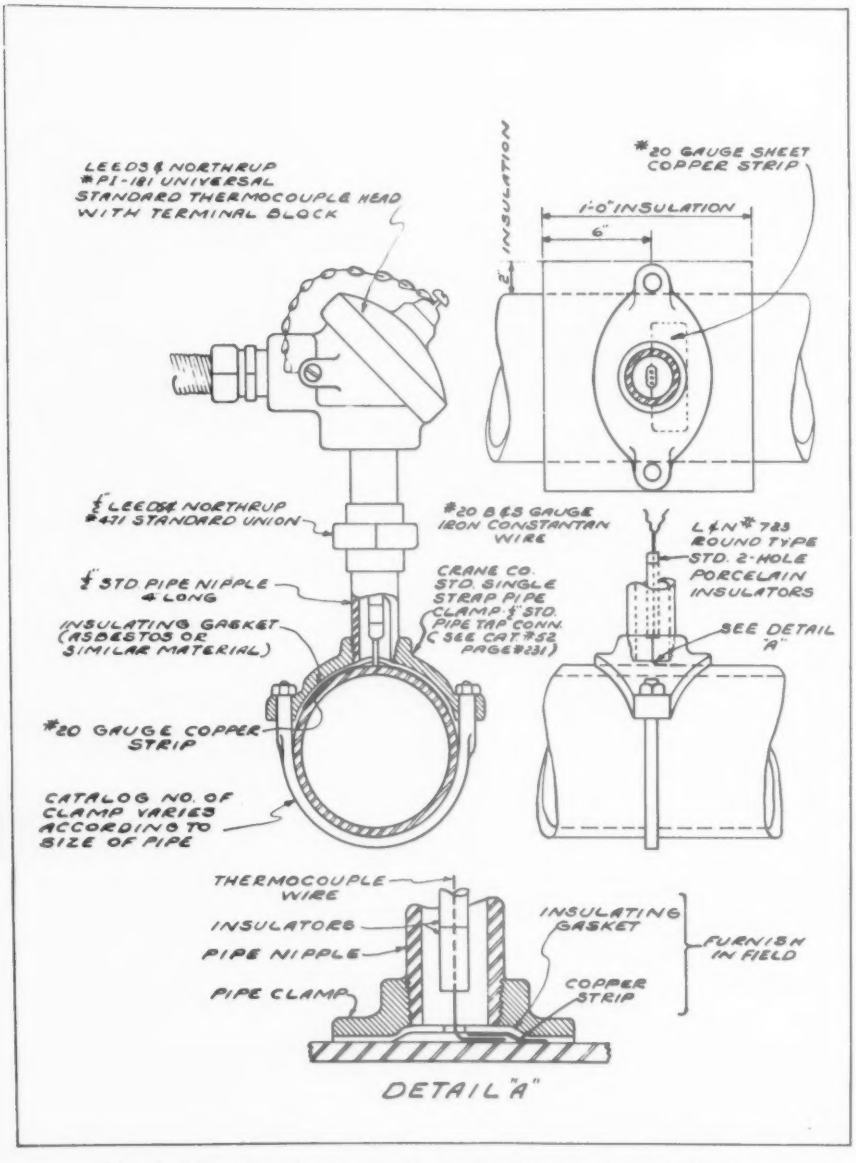
LEEDS & NORTHRUP #P1-181 UNIVERSAL STANDARD THERMOCOUPLE HEAD WITH TERMINAL BLOCK
2" INSULATION
#20 GAUGE SHEET COPPER STRIP
1'-0" INSULATION
6"
LEEDS & NORTHRUP #471 STANDARD UNION
#20 B&S GAUGE IRON CONSTANTAN WIRE
L & N #723 ROUND TYPE STD. 2-HOLE PORCELAIN INSULATORS
SEE DETAIL "A"
CRANE CO. STD. SINGLE STRAP PIPE CLAMP FOR STD. PIPE TAP CONN. (SEE CAT. #52 PAGE #231)
STD PIPE NIPPLE 4" LONG
INSULATING GASKET (ASBESTOS OR SIMILAR MATERIAL)
#20 GAUGE COPPER STRIP
CATALOG NO. OF CLAMP VARIES ACCORDING TO SIZE OF PIPE
THERMOCOUPLE WIRE
INSULATORS
PIPE NIPPLE
PIPE CLAMP
INSULATING GASKET
COPPER STRIP
FURNISH IN FIELD
DETAIL "A"

Fig. 4—Skin-type thermocouple used for temperature indication

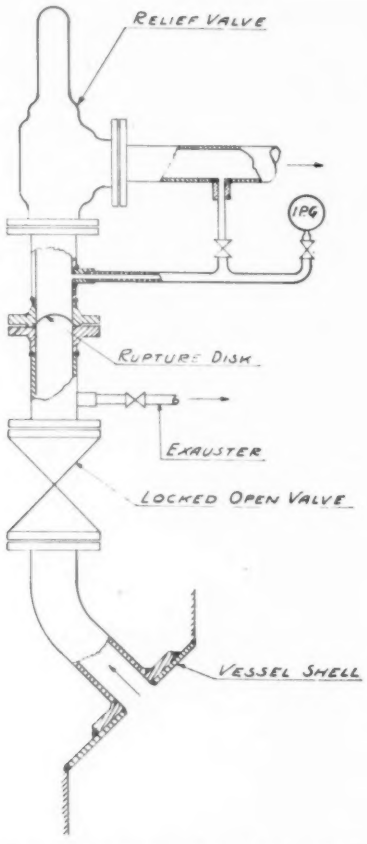

Fig. 5—Typical relief valve for HF service

safety head and the relief valve is normally open to the relief header; it is closed only for the purpose of detecting a leak in the rupture disc. By closing the valve in the connection and opening the valve against the pressure gauge, one can detect whether or not the safety head has developed a pinhole leak.

In addition to the regular safety valves, there is an auxiliary relief system, which is set to operate at a pressure 15 to 20 psi below the relief-valve setting. This blow-down system consists of a closed tank that is capable of receiving the entire contents of the contactors and acid settler. Each contactor and acid settler is equipped with a hydraulically operated drop-out valve, which is automatically operated. It may also be remotely controlled from the instrument board, or manually operated.

Drain and Exhauster System

A system whereby HF and hydrocarbons can be purged from any part of the system by evacuation was substituted for the conventional vents and drains. The exhauster clusters are usually limited to from 4 to 8 process connections so that valve leaks can be more easily located. A hydrocarbon seal prevents leakage of HF between the process equipment and the exhauster header.

The utilities are an important factor in the economical operation of an alkylation plant, and some changes were made from the ordinary design in order to utilize water and steam in the most economical manner. In general, the entire volume of cooling water required in the unit is passed through the cooling bundles in the contactors, where the rise in temperatures is usually about 1½° F. The water is then taken to the low-temperature-level condensers and coolers, and is finally used in the higher-temperature-level equipment. In this manner it is possible to economize on condenser and cooler surface. The water is usually returned to the cooling tower at about 115° F., so that satisfactory cooling tower efficiency results. Recording pH instruments were installed for detecting any HF leaks into the water system.

Temperatures

The bottom temperatures on the various fractionation columns vary from 175° F. to 375° F.; and, for the greatest economy, it was found that, if all of the steam was supplied at 400 or 425 psi and 50° F. or 75° F. superheat, most of the power required for pumping and circulating could be taken out of the steam prior to its use in low-temperature reboiler service. That is, turbines will operate on steam at a pressure of 400 psi gauge on the governor and on exhaust at a pressure of 45 psi. The exhaust steam will be at a satisfactory temperature for reboiling the low-temperature towers. Other turbines discharging at 150 psi supply steam to the intermediate-level reboilers.

Commercial Results

Several commercial HF alkylation plants are in operation, and a number of others will be completed in the near future. The results obtained have come up to expectations based on pilot-plant data. The aviation alkylate has an octane number of about 93 A.S.T.M. The fluorine content of the aviation alkylate has consistently been less than 5 parts per million. The mechanical troubles encountered have not been greater than those experienced normally in oil refinery equipment.

The HF alkylation process is typical of the war developments of the petroleum and chemical industry. Through the cooperation of research workers, development and design engineers, HF manufacturers, and equipment suppliers, it has been possible to bring a new process into commercial operation in time to aid in meeting the serious problem of supplying the wartime aviation gasoline requirements.

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5. Carlson, A. J., University of Chicago, Treatment of Hydrofluoric Acid Casualties, published by Universal Oil Products Company.

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New Type Direct Displacement Device For Testing LPG Cylinders

Apparatus is described and the operation of a direct displacement test by atmospheric pressure measuring for determining the condition of liquefied petroleum gas cylinders of the convex head type. The method was developed by an oil company to replace the generally accepted water jacket displacement test. Advantages of the new procedure are smaller investment for apparatus and less time required for running the test.

*By T. A. St. Clair**

CYLINDER TESTING is the custodian of safety of the compressed gas industry in the protection of life and property. The importance of actively determining the condition of cylinders in service is well recognized by the industry and great emphasis has been placed on their periodic accurate test. Considerable work has been carried out in the past by the Bureau of Explosives and private industry towards the development of improved testing specifications. Also, testing methods have been given consideration in so far as accuracy is concerned but efficiency has been somewhat neglected. The Phillips Petroleum Co., confronted with an ever increasing quantity of cylinders requiring retest, began a development program in the latter part of 1940, from which a simplified testing apparatus evolved.

Regulations**

Practically all of the cylinders used in the U. S. today are fabricated under the Interstate Commerce Commission regulations. As a typical interpretation of these regulations, cylinders constructed in compliance with specification I.C.C. 4B would require for retest the following essentials:

(P) (13) (a) Quinquennial retest of cylinders—Each cylinder must be subjected, at least once in 5 years, to a test by interior hydrostatic pressure in a water jacket or other apparatus of suitable form, as approved by the Bureau of Explosives.

(P) (13) (c) In this test the pressure must be applied for at least 30 seconds and as much longer as may be necessary to secure complete expansion of the cylinder. The gauge indicating the total expansion of the cylinder must be such that the total expansion can be read with an accuracy of 1%, except that a reading to 0.1 cubic centimeters shall be acceptable. The gauge indicating the pressure must be capable of being read to within 1% of the test pressure.

(P) (13) (d) A cylinder must be condemned when it leaks or when the permanent expansion exceeds 10% of the total expansion. Cylinders condemned on account of excessive permanent expansion may be further handled under sec 303 (p) (12).

(P) (14) (a) The retest pressure for ICC-4B containers must be 2 times the service pressure, the service pressure being defined as that which is marked on the container. For example, for containers marked ICC-4B-240 the final figure denotes the service pressure and the retest pressure is 480 psi.

Water Jacket Tester

The current generally accepted method of testing cylinders is by water jacket displacement. With this procedure, a cylinder is filled with a testing liquid (usually water or kerosine) and then is completely immersed in a jacket of water. The application of hydraulic pressure to the interior of the cylinder will expand the cylinder and displace water from the external jacket to a measuring burette. The water displaced into the burette at the test pressure is known as the "total expansion". This volume includes the changes in cylinder volume due to (1) original distortion, (2) elastic expansion and (3) possible permanent stretching of the steel.

The water displacement indicated by the burette upon removal of pressure represents the "permanent expansion" of the cylinder, this being caused by permanent stretching of the steel and/or distortion removed from the cylinder. The difference between the total expansion and the permanent expansion is the elastic expansion of a cylinder. This figure will give a definite clue as to the wall thickness of the container and can be compared with a calibrated cylinder for determination of the cylinder's suitability in this respect.

Practical Problems Of Water Jacket Testing

Water jacket testing is unquestioned from a standpoint of reliability, but a number of operational inconveniences and limitations are inherent with this system. The principal objection is the necessity for using a testing fluid both inside and outside of the container on test. Dependent upon this is the necessity for manipulation of special equipment for handling the water jacket fluid, removing the test cylinder from the jacket and sealing the jacket or preparing an overflow. The time consumed in these miscellaneous supplementary operations is enormous in comparison with the actual testing time. Another minor objection to the water jacket method is that the size of the jacket limits the size of the container which can be tested.

With the above considerations in view, development work, culminating in the tester to be immediately described,

Photo above shows the apparatus for the direct displacement method for testing liquefied petroleum gas cylinder

*Phillips Petroleum Co., Bartlesville, Okla.
**ICC Freight Tariff No. 4, Jan. 1941.

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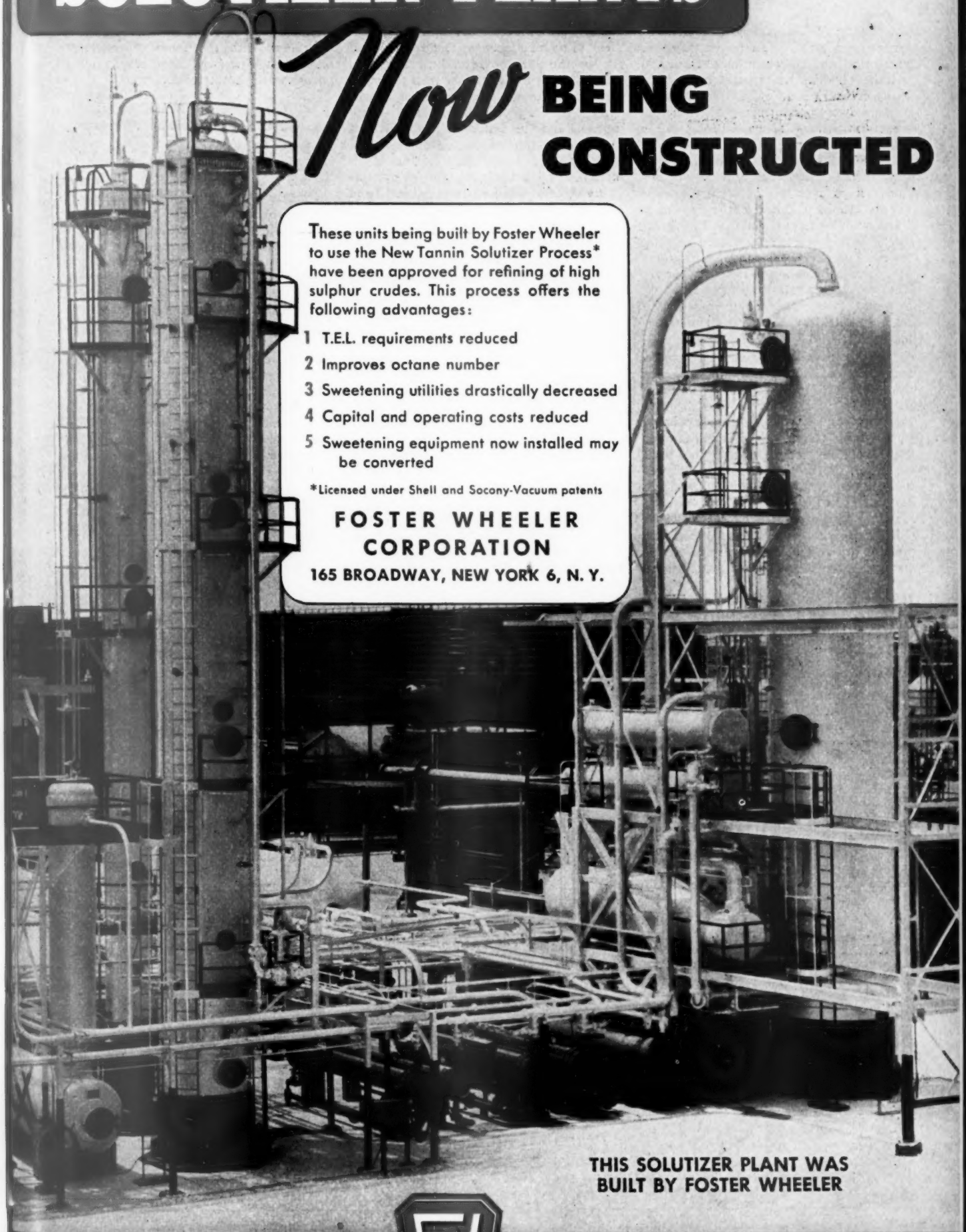

These units being built by Foster Wheeler to use the New Tannin Solutizer Process* have been approved for refining of high sulphur crudes. This process offers the following advantages:

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3. Sweetening utilities drastically decreased
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was begun. The direct displacement testing apparatus (atmospheric pressure measuring) consists essentially of a liquid volume chamber interposed between a hydrostatically filled cylinder on test and a source of pressuring gas, with external provisions for measuring in a burette the transfer of liquid from one portion of the system to another. Fig. 1 depicts the equipment and the operational steps involved in testing a container. In Step 1, the entire system is filled with a testing fluid (kerosine) at atmospheric pressure to a zero reading on the burette. The constriction above the volume chamber is not transparent. The 0-0 identification is intended only to portray that this level agrees with the initial burette level, valves 2 and 6 being open to atmospheric pressure.

In Step 2, valves 2 and 6 are closed and nitrogen is admitted to the system through valve 1, displacing kerosine from the volume chamber into the cylinder on test. Assuming the expansion of the tubing and the volume chamber are negligible, V_1 represents the total expansion of the container on test plus the compressibility of the testing fluid, hereinafter called the compressibility, for that particular size container.

In Step 3, valve 4 is closed and the pressure on the cylinder is released by opening valve 6, the liquid being transferred from the cylinder to the burette. The difference between readings I and II on the burette represents the total expansion of the container plus the compressibility minus the permanent expansion. In Step 4, valves 2 and 4 are opened and the liquid in the burette is returned to the volume chamber to the 0-0 height. The "total expansion" is obtained by subtracting the compressibility figure (obtained from tables) from the difference between readings II and III. The "permanent expansion" is the difference between readings I and III.

Tabulations of compressibility for the various sizes of cylinders were derived originally from the International Critical Tables. Due however to the solubility of the nitrogen in the kerosine, it was necessary to apply slight correction factors for all temperatures. These corrections were obtained through the use of a comparative water jacket tester operating under closely controlled conditions. The water jacket tester was in turn used in an extended series of tests to check the accuracy of the direct displacement tester. Simultaneously tests by both methods were run on cylinders withdrawn from active service. All results were in agreement to tolerances limited by the accuracy of the testing equipment —well within the tolerances set by the Interstate Commerce Commission regulations. Tests conducted on calibrated cylinders with the direct displacement tester itself showed that results at all times were reproducible.

Comparison of Water Jacket and Direct Displacement Testing

Direct displacement testing by atmospheric pressure measuring offers a simplified and accurate method of retesting cylinders of the convex head variety. It cannot be recommended for concave or "dished-in" head containers because of difficulties involved in removing trapped air. The investment required is considerably less than for the water jacket type. Cylinder testing ordinarily is considered as a part of a general program which includes cleaning the cylinder exterior, repairing and testing the valves and relief valves, checking the tare weight, stencilling the new test dates and frequently includes repainting. Considering the cylinder test only, direct displacement testing as herein described will reduce an operator's time to approximately one-fourth that required by the water jacket type. This will represent an appreciable saving in the overall maintenance of cylinders, the percentage savings, of course, being reflected in the volume of cylinders handled and the supplementary equipment used.

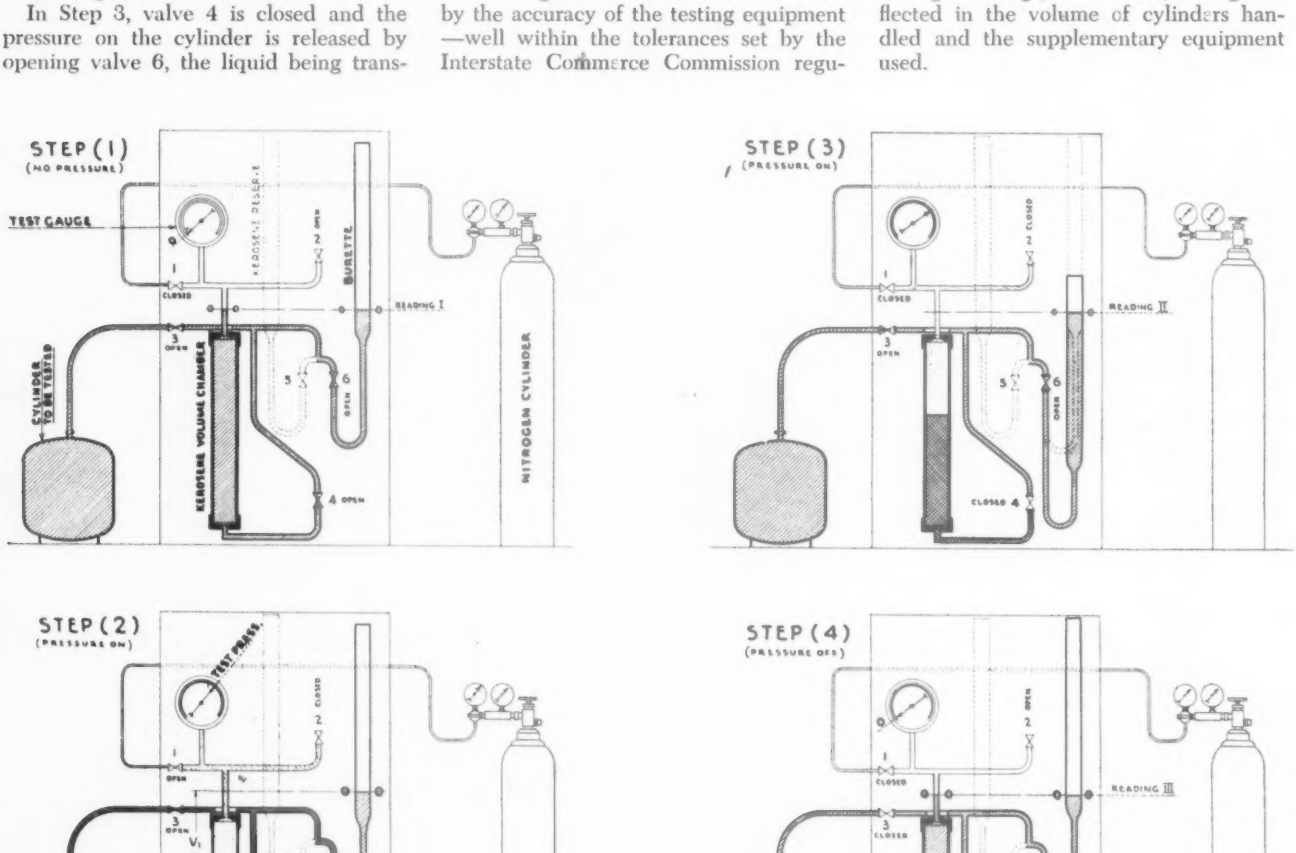


Fig. 1—Equipment and operational steps in the direct displacement method for testing liquefied petroleum gas cylinders

Reclaiming Pumps By Metallizing

Two Refinery Technicians Win War Bond Prizes in Manufacturer's Contest by Describing Modern Method Used in Their Plants To Repair Worn Parts and Thus Conserve Replacement Alloy Steel

Savings in down-time, money, and war-scarce materials are reported by two Pennsylvania refiners by the repair of worn, scored pump rods and cylinder liners with sprayed metal coatings.

Rods from various makes of pumps, mostly of the reciprocating type, have been built up to original finished dimensions with several passes of sprayed stainless steel, followed by grinding to the desired surface, one refiner reports. Some rods are of alloy steel, others are bronze, while some, to replace rods worn beyond repair, were turned from cold-rolled steel bar stock before spraying with stainless steel. Some of the bronze rods are in high-pressure service on products which carried no lubricant.

The other refiner repaired a 12 x 5 x 12 pump liner from the liquid cylinder of a reciprocating pump, handling crude oil containing sulfur, salt, water, and ammonia, by metal spraying with a chrome-carbon stainless steel. Formerly, liner service-life was from 4 to 6 weeks. Replacement cost, plus down-time, is saved with the metallized liners. For example, a sprayed liner has been in continuous service for more than a year, 24 hours a day, without appreciable wear, and is expected to last 5 more years.

Details of these achievements, with cost data, as described by the technicians in charge of the work, won prizes for them in the Conservation Contest for outstanding jobs done with metallizing conducted by the Metallizing Engineering Co., Inc., New York. Their contributions are published below.

Replacing Refinery Pump Rods Without Replacements

By W. J. Taylor,

(Machine Shop Foreman, Sinclair Refining Co., Marcus Hook, Pa.)

With approximately 700 pumps in use here at the Marcus Hook refinery, maintenance of pump rods had become a serious problem in many ways until metallizing equipment was installed. However, thanks to this modern method of reclaiming worn parts, we are not only getting far longer uninterrupted service from these pumps, but are saving annually many hundreds of man and machine hours and thousands of pounds of alloy steel formerly required in making replacements.

These pumps—largely of the reciprocating type—are made by various manufacturers, including Union Steam, Worthington, National Transit, Dean Brothers, Blake-Snow, and Gardner-Denver. They operate under pressures up to 300 lb, and at temperatures as high as 650°F. Rods range in diameter from 3½ in. to ¾ in., and from 8 ft to 4 ft in length.

Due to the severe and varied conditions under which the pumps operate, wear occurred rapidly at the packing areas of the rods. Furthermore, uneven wear and scoring at these areas demanded frequent replacement of the packing. This was particularly true on hot and cold gasoline pumps, where rod life varied from 2 months to as little as 2 weeks.

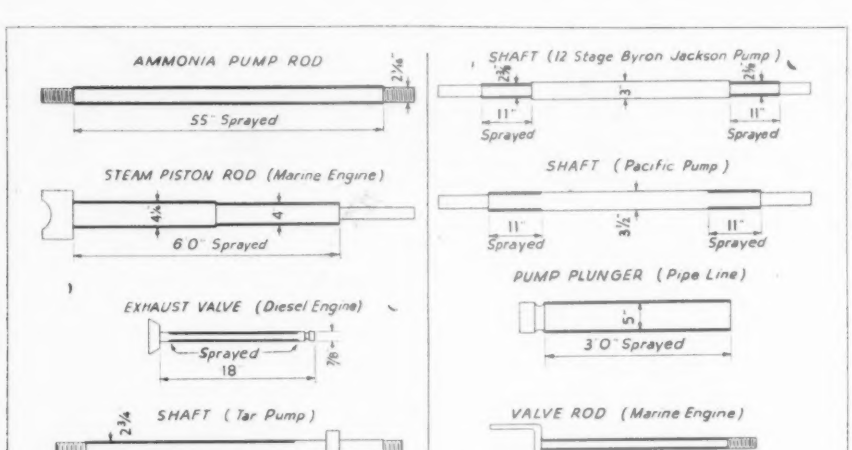
Previously it had been our custom to make up new rods in our machine shop from stainless steel bar stock. Average cost for a rod replaced in this manner and ready for installation was approximately $30. But under current conditions it would, of course, be impossible for us to obtain alloy stock in the large quantities required. As these rods wore, we had no method of reclaiming them, but would re-machine the large rods and use them in smaller pumps. This procedure, however, was expensive and required a continual cutting away of materials. Morever, the smaller rods eventually found their way to the scrap pile.

By metallizing each worn rod and then re-metallizing as wear occurred again, we not only save the time and cost of turning down old rods, machining to a tapered fit, and threading for pistons and cross heads, but have eliminated the purchase or manufacture of replacements completely. In addition, it is estimated that the wear- and corrosion-resistant qualities of the sprayed metal, as compared with those of the base metal, have increased rod life as much as 800%. Equally significant is the increase in the life of pump packing. This has risen to almost 80% more than that obtained with the unmetallized rods.

Preparation of Rods

A standard procedure has been adopted in the metallizing of these rods. First, the rod is mounted in a lathe, and worn sections are undercut 1/16 in. on the diameter. This undercut section is extended about 1 in. beyond each end of the worn portion. Next, a 30° pitch thread is run across the undercut area, after which it is treated with a shaft preparing tool. For a rod of average length—1-5/16 in. in diameter and 4 ft long—the time required for these steps is 30 minutes.

Spraying follows immediately, using a chrome-carbon stainless steel. Our gun is mounted in the tool holder, with the work revolving at 63 rpm, and with the carriage advance 1/30 in. per revolution —or 7½ threads per inch. Successive passes are made with the metallizing



The parts shown are typical of those restored to service in a single refinery by metallizing the worn surface. This oil company estimates that every month it conserves 2585 pounds of metal in parts by using only 103 pounds of sprayed metal

gun until sufficient metal has been applied. Normally, a coating .008 in. thick provides adequate allowance for finish grinding. Thirty-five minutes is the average time needed for spraying.

As soon as the metallizing operation is completed, the gun is removed from the carriage and replaced by a tool post grinder. Spindle speed is set at 63 rpm, and an advance of 1/120 in. per revolution—or 30 threads per inch. This final step is completed in 1 hour 55 minutes. Total time for preparation, spraying, and grinding: 2 hours 55 minutes. Total cost, including metallizing wire: $5.25.

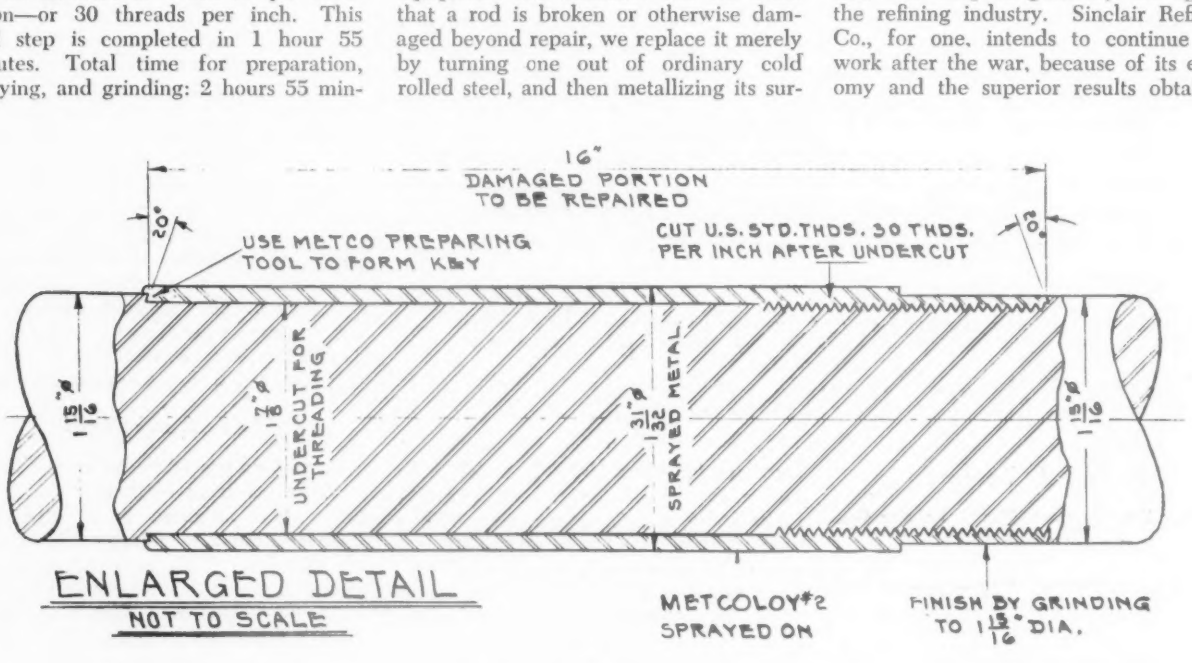
Steel and Bronze Rods also Metallized

We are now getting better results from sprayed rods than we did from the original alloy rods. Records show that we have not purchased a single pound of alloy stock for pumps since metallizing equipment was installed. In the event that a rod is broken or otherwise damaged beyond repair, we replace it merely by turning one out of ordinary cold rolled steel, and then metallizing its surface with a chrome-carbon stainless steel. With proper grinding we thus obtain a finished rod of stainless steel at the cost of cold rolled. This also applies to bronze rods which, operating under high pressures and where the product carries no lubricant, would rapidly become scored but for the metal spray coating.

Saving Materials, Time and Money

During the past year we have reclaimed approximately 100 rods by metallizing. To duplicate these rods by former methods would have taken 4000 lb of alloy steel, required 2200 man-hours to fabricate and would have cost about $3000. With metallizing, however, we have consumed only about 200 lb of stainless steel in wire form. Total time required for preparing, spraying, and finishing the 100 rods has been less than 300 man-hours, at a total cost of but $525.

While the reclamation of pump rods is our largest single application of metallizing, we have used the equipment in various other ways. For example, numerous types of valve seats, as well as liners for re-bored pump cylinders, have been built up with sprayed metal. But the successful metallizing of pump rods is alone an indication, we believe, of the vast savings in strategic alloys and man-hours possible if this method of reclamation was adopted generally throughout the refining industry. Sinclair Refining Co., for one, intends to continue this work after the war, because of its economy and the superior results obtained.



Design for metallizing pump rod for 12 x 6½ x 12 Worthington duplex steam pump. One pound and 14 oz. of metal were sprayed on the surfaces; time for preparing rod, 30 min.; time spraying rod, 35 min.; time for finishing rod by grinding, 1 hr. 50 min.; total time for entire operation, 2 hrs. 55 min.

The remarkable results achieved by the Universal organization would have been impossible without the fine cooperation and support of refinery executives and operating men throughout the industry

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Increasing Life of Cylinder Liners From 6 Weeks to 6 Years

By Ross McClain, Freedom Oil Co., Freedom, Pa.

Scored cast iron pump cylinder liner which was replaced with a steel liner with a stainless steel metallized surface

An increase in service life from weeks to months is not uncommon when moving parts are protected with sprayed metal. From 6 weeks to 6 years, however, may seem a little too much to expect. But this is the added usefulness we expect to get from metallized pump cylinder liners at Freedom Oil Co., Freedom, Pa.

The particular liner described here is from the liquid cylinder of a Worthington horizontal duplex piston pattern pressure pump. This pump is used in handling crude oil containing sulfur, salt, water, and ammonia. Size originally was 12 x 5 x 12.

Due to heavy use and the highly corrosive action of the liquid handled, the average life of such liners when made of cast iron is frequently as little as 4 weeks, and never more than 6 weeks. Before the advent of metallizing, repairs were made by boring out enough of the liner to remove the score, and installing larger piston rings. The cost for labor and materials by this method was approximately $25 per liner. There are two liners to a pump. Since it was not possible to improve the wearing and corrosion-resisting qualities of the liner, the increased service life was no more than before.

Therefore, as an experiment, it was decided to remove the worn cast iron liner and substitute a 10 carbon steel liner metallized with a chrome-carbon stainless steel. Such a liner was installed over a year ago, and the results have more than justified our intention of metallizing the cylinder walls of 30 similar pumps in this plant.

Good for 6 Years' Service

During this period of 12 months and more, the metallized cylinder liner has been in continuous service 24 hours a day without replacing cups or packings. And still it shows no appreciable wear. At this rate we estimate that the metallized steel liner will give 6 years of useful service, whereas a shutdown for replacement or repair of cast iron liners was needed at least every 6 weeks.

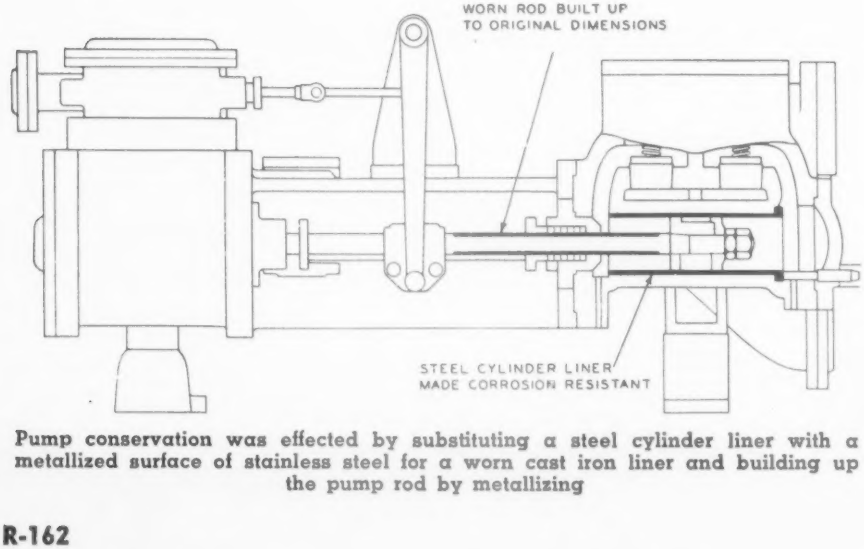
Added to the all-important elimination of frequent production time losses is the fact that maintenance with metallized liners entails far less initial investment in labor and materials.

Rough grooving and then preparing the cylinder liner with a shaft-preparing tool takes approximately 2 hours. Building up the roughened surface 1/16 in. on the radius requires 1 hour's time, and 9 lb of chrome-carbon stainless steel. Finish grinding with a tool post grinder takes another hour.

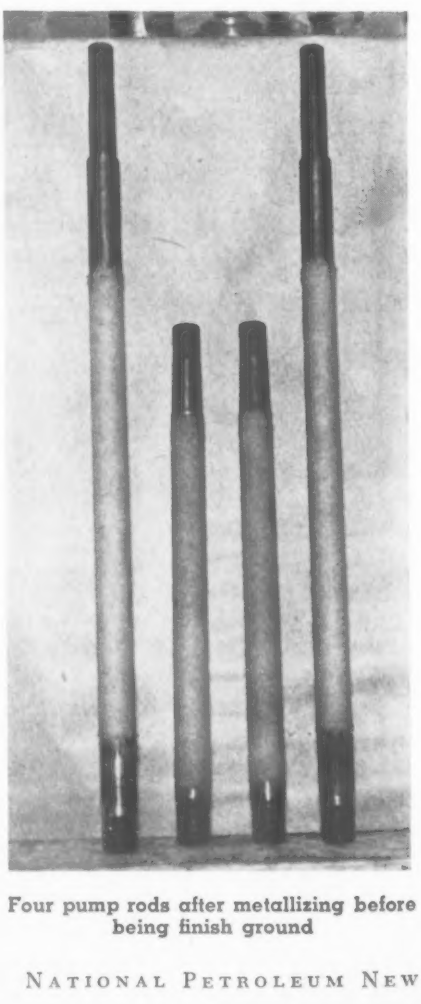
Other Applications

This application probably ranks highest in importance among all the maintenance jobs done with metallizing in this plant. However, we have been extremely successful in the building up of worn pump rods for these Worthington piston pumps, as well as impellers, shaft sleeves, seal rings, and gland sections for centrifugal pumps. Another was a rotor shaft journal and sleeve type bearing from a 40 hp G.E. motor on an ammonia booster pump.

An urgent repair problem, worthy of mention because of its rapid solution with metallizing, was encountered on a boiler feed pump 40 hp Westinghouse steam turbine. The thrust end of the shaft bearing had seized and ruined the journal. The shaft had corroded at the steam seals and could not hold steam. This turbine was dismantled and metallized at the 2 bearing and 2 steam seals with 18-8 stainless steel—and restored to service the same day. It would have taken us over 6 months to get a new shaft, and at least a week to have had the job done outside.



Pump conservation was effected by substituting a steel cylinder liner with a metallized surface of stainless steel for a worn cast iron liner and building up the pump rod by metallizing



Four pump rods after metallizing before being finish ground

The Refining of Permian Basin High Sulfur Crudes*

Analysis of the properties of the high sulfur crude from the Slaughter field in West Texas is presented, since most of the additional crudes available to the Mid-Continent refiners will come from this field. While it is difficult to reduce the salt content to a desired level by conventional methods, conventional salt settling may be satisfactory for blends of Slaughter and low sulfur crude oils. The effect on sulfur content is studied of blending various percentages of straight-run gasoline from Slaughter crude with gasolines of lower sulfur content. Similar charts are presented showing the effects of various percentages of Slaughter cracked gasoline blended with gasolines of lower sulfur content. These serve as an index to the blending of Slaughter and low sulfur crudes.

*By F. C. Moriarty***

THE Petroleum Industry War Council has reached the conclusion that practically all the available refining capacity in Dist. No. 2 must be utilized to fulfill the long term program designed to produce the maximum quantity of vitally needed petroleum products. To accomplish this, the council has indicated that runs of high sulfur crude to Dist. 2 refineries will rise to 159,000 b/d in the third quarter of 1944 if the region is to keep its total throughput up to program levels. This additional quantity of high sulfur crude will come from the West Texas-New Mexico area.

The introduction of high sulfur crudes to Mid-Continent refineries presents a serious problem. Corrosion rates on carbon steel are extremely high when processing the high sulfur West Texas crudes, many of which contain large quantities of salt which must be removed before the crude oil can be satisfactorily processed. The products from these crudes are high in sulfur content and require special treating methods.

The present discussion is limited to the West Texas crude oil produced from the Permian Basin and more particularly from the Slaughter pool of Hockley and Cochran counties. These crude oils are of special interest at this time since it is from this area that most of the additional production intended for District No. 2 will probably be obtained. Few refiners have processed Slaughter crude and only one refinery has operated on a charge consisting of 100% Slaughter.

Table I shows an analysis of Slaughter crude oil and various fractions produced therefrom. It will be noted that the straight-run gasoline has a higher octane number than the usual Mid-Continent product. A 21% by volume Diesel oil fraction had a cetane number of 50.5. The sulfur content of the various fractions increases in inverse ratio to the A.P.I. gravity. At present, the salt content of the crude produced from this field averages from 200-300 lbs. per 1000 bbls. In winter months this may increase to 400-500 lbs. per 1000 bbls. and it is quite possible that when the production from this field is increased, the salt content will also increase.

Crude Blending

It would be desirable in many respects if conditions permitted refiners to segregate Mid-Continent and West Texas stocks. This would permit the manufacture of the most desirable products from each crude since each is superior in certain respects. Unfortunately, the additional storage facilities and the extensive changes in processing equipment to permit charging straight crudes such as Slaughter will make this an almost impossible consideration during the war period. With this in mind, much of the information in this paper has to do with blends of Slaughter and low sulfur crudes.

Sulfur Limitations

When high sulfur crudes must be utilized, the limitations governing total sulfur content present a definite handicap in economically processing these oils. The situation today is not nearly as restricted as a few years ago. The Federal Government specifications covering total sulfur have recently been increased from 0.1 to 0.25%. In recent years, the sulfur limit in most states has been raised to 0.25%. It has been firmly established that sulfur contents of 0.25% or higher in ordinary motor fuel are not injurious to motors. In fact, much gasoline which contained 0.4% total sulfur or higher has been marketed without difficulty. In spite of this, a few states still have a sulfur limit of 0.1%. These arbitrary specifications

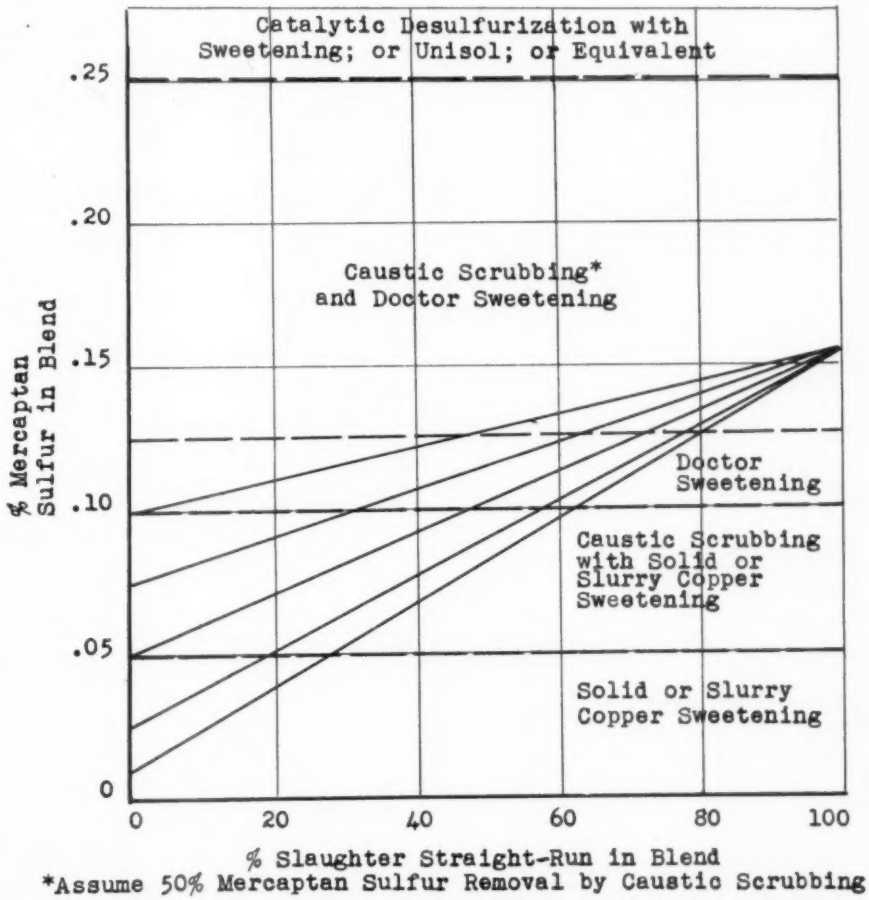


Fig. 1—Recommended treatment for blends of Slaughter straight-run with gasolines having various mercaptan contents

*Presented before Western Petroleum Refiners Assn., Wichita, Kans., Oct. 19, 1943.

**Universal Oil Products Co., Chicago.

present an unfair handicap to refiners who process high sulfur crudes and every effort should be made to remove these limitations. In some states, it may be necessary some day to pay a premium for gasolines which contain less than 0.1% sulfur if this specification remains in force. To market gasoline in these states when West Texas high sulfur crudes must be refined, it will be necessary in most cases to segregate high and low sulfur stocks. This will require additional storage facilities.

If a large proportion of the gasoline produced from West Texas high sulfur crudes must be marketed at the 0.1% specification, the refiner must resort to expensive methods of processing, such as severe treatment with sulfuric acid.

Salt Removal

When considering Slaughter crude as charging stock for a refinery, the first major problem will be that of reducing the salt content to a reasonable level. Since large quantities of salt will increase corrosion rates within the refinery and deposit in heater tubes, it is necessary to reduce the salt content to a low value. Reduction to less than

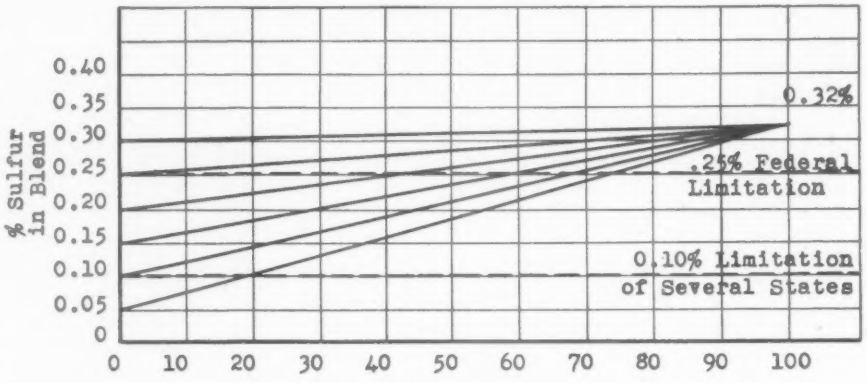


Fig. 2—Slaughter straight-run gasoline blended with gasoline "X" (No sulfur reduction)

Right, Fig. 3—Slaughter straight-run gasoline blended with gasoline "X" (Mercaptan sulfur of Slaughter gasoline reduced 50%)

Table 1—Analysis of Slaughter Crude Oil and Fractions

Fraction	Crude Oil	375°F. E.P. Gaso.	Dr. Swt. 375°F. E.P. Gaso.	Gas Oil	Topped Crude After 375°F. E.P. Gaso.	Gas Oil	Dist. Loss
Yield Vol. % of Crude	100.00	31.7		21.1	68.1	47.0	0.2
Analyses of Fractions							
Gravity, °API @ 60°F.	31.6	56.6	56.5	36.1	22.2	16.8	
Sp. Gr. @ 60°F.	.8676	.7523	.7527	.8443	.9206	.9541	
Total Sulfur, %	2.02	.28		1.23	2.75	3.25	
Mercaptan Sulfur, %		.117*					
R.V.P., lb./sq. in.		6.2	5.2				
Octane No., M.M.		56.5	55.0				
Octane No. M.M. + 1cc. TEL			61.0				
Octane No. M.M. + 3cc. TEL			68.5				
Cold Test, °F.	—5			below 0	50	65	
B. S. & W., %	.2				.2	.3	
Viscosities							
Kinematic @ 100°F., Cs.	5.52			2.42	39.68	409.3	
Kinematic @ 210°F., Cs.					6.10	20.95	
Univ. @ 100°F., Sec.	44.0			34.2	184	1890	
Univ. @ 210°F., Sec.					45.8	101.5	
Aniline No., °F.,				139.6			
Aniline No., °C.				59.8			
Cetane No.				50.5			
100 Ml. Distillation							
I.B.P., °F.	134	107	115	404	425	619	
5%	189	150	153	422	458	637	
10	226	166	173	431	481	653	
20	290	190	196	446	527	671	
30	371	207	214	460	584	698	
40	480	225	230	473	639	713	
50	570	243	247	485	680	729	
60	647	262	264	500	691	738	
70	681	282	283	515	703	749	
80	716	305	303	534	713	758	
90	750	332	333	563	720		
E.P.	754	374	376	619	720	760+	
% Over	96.0	98.5	98.5	99.0	93.0+	92.0	
% Bottoms		1.0	1.0	1.0			
% Loss		0.5	0.5				
% Coke by Weight	3.8				5.9	7.8	
% Over at 400°F.	32.5						
% Over at 572°F.	50.2			93.0	28.5+		

*Lower than average; apparently some oxidation had taken place during shipment of sample.

25 lbs. per 1000 bbls. is generally recommended.

It has been estimated that approximately 50% of the salt present in Slaughter crude is in crystalline form. In view of this, it is difficult to reduce the total salt content to a satisfactory level by conventional methods of desalting. If electrical methods are employed, satisfactory results probably will be obtained if the salt content of the crude is below 200 lbs. per 1000 bbls; above this figure two-stage electrical desalting may be necessary. One refiner is now reducing the salt content of this crude from 200-400 lbs. of salt per 1000 bbls. to 15-20 lbs. by a two-stage non-electrical process. The second stage of this process is a typical salt settler operating at 325°F. The details of the first stage of this process cannot be disclosed at this time.

To illustrate the difficulty of removing salt from this crude, a typical single-stage salt settler operating at 350°F. was only about 50% efficient. The most practical method of handling the salt concentration of this crude may be to charge only blends of Mid-Continent and Slaughter crude in which the percentage of Slaughter is sufficiently low so that a high salt content is not obtained. If blends are used, the conventional salt settling equipment may prove satisfactory.

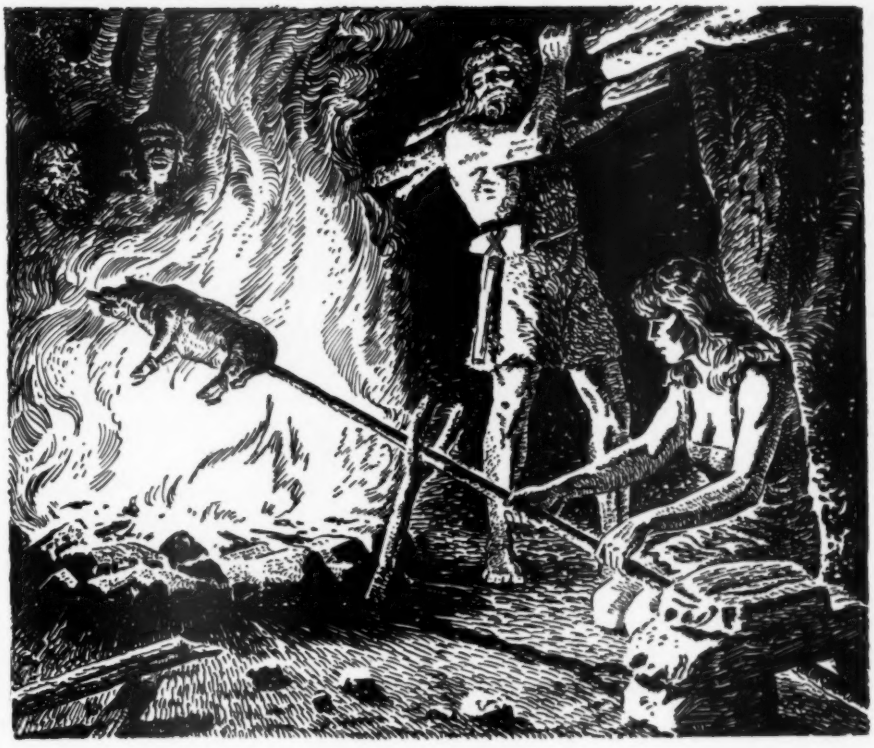
Those refineries producing asphalt may find this a convenient method of avoiding the salt problem. Slaughter crude contains 20-25% of 100 penetration asphalt of high quality. Reduction of the crude to asphalt produces a salt-free gas oil which can be used as charging stock to cracking.

Crude Distillation

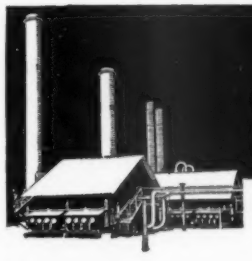
From an operating standpoint the processing of this crude in a topping unit will be much the same as when charging Mid-Continent crude oils. The corrosion rates and maintenance will be somewhat higher but, in general, carbon steel equipment can be used unless temperatures in excess of 600° to 650°F. are encountered. Ammonia should be introduced into the overhead stream from the crude column to prevent hydrochloric acid corrosion in the overhead condensing system. It is recommended that ammonia be added either to the top tray or directly into the vapor line. If ammonia is added low in the column, deposits will be formed on the bubble trays.

The treatment of the straight-run products from Slaughter crude oils requires special consideration.

Considerable hydrogen sulfide is evolved in crude distillation, and the straight-run gasoline should be caustic washed immediately to remove all traces of hydrogen sulfide before going to run-down storage. If gasoline containing



Civilization's progress paralleled the advances of man in the application and control of fire for comfort and health. The use of fire for the preparation of food gave civilization a great impetus. Through the centuries, fire has continued to be the dynamic for progress in every pursuit. Without the scientific application of heat, petroleum refining might never have achieved its colossal importance. Twenty years ago, Alcorn pioneered in the engineering development of efficient, economical heaters for petroleum processing. Alcorn installations in major refineries of the world are proving their merit. Alcorn knowledge and long experience are at your disposal for the solution of your heating problems.



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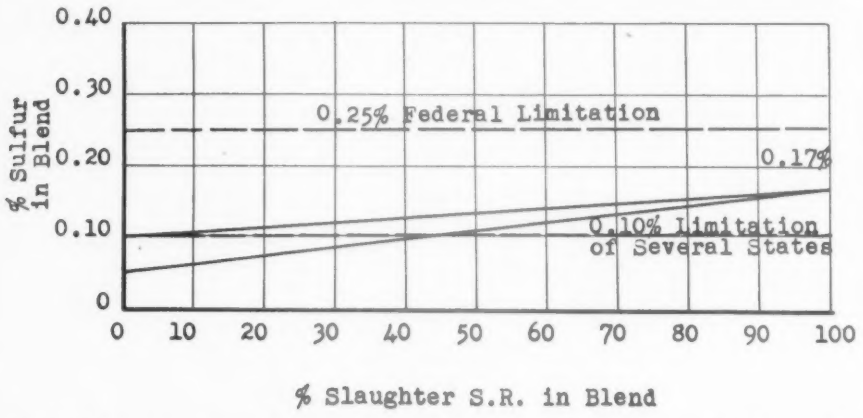


Fig. 4—Slaughter straight-run gasoline blended with gasoline "X" (Slaughter gasoline Unisol treated)

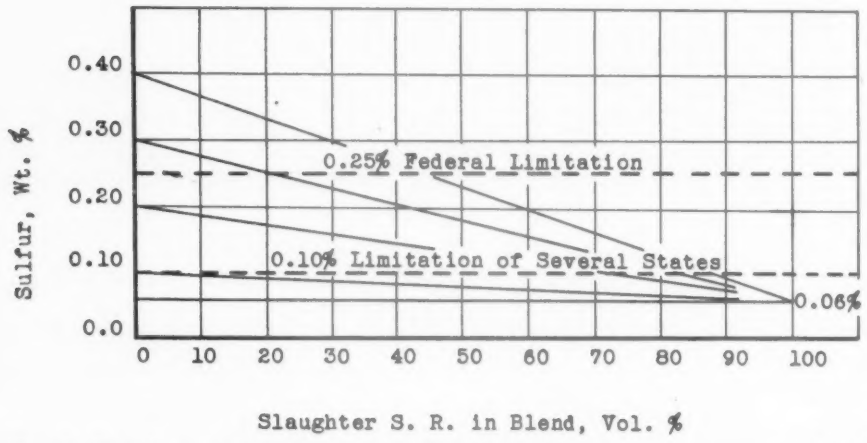


Fig. 5—Slaughter straight-run blends (Desulfurization treatment; temp., 700° F; pressure, 20 psi; space velocity, 1.0)

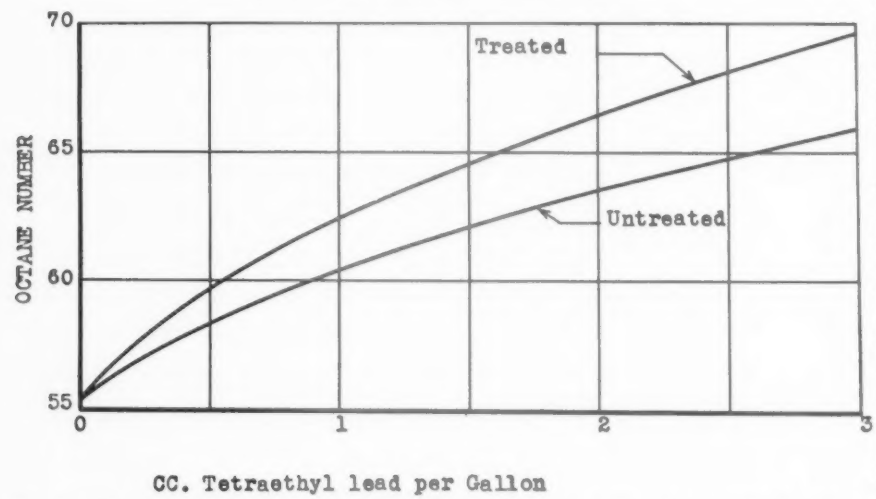


Fig. 6—Effect of Unisol treating on lead susceptibility of Slaughter, 400° F. E.P., straight-run gasoline

hydrogen sulfide reaches the rundown tanks, some oxidation may occur, causing the formation of free sulfur which may make the final product corrosive. The presence of hydrogen sulfide in gasoline storage will also increase corrosion of storage equipment and, since it is extremely poisonous, presents a potential hazard.

Gas masks should be worn at all times when gauging tanks where there is a possibility of the presence of hydrogen sulfide.

If the percentage of Slaughter crude oil is high in the charge, a large amount of caustic soda will be consumed in removing the hydrogen sulfide. For this reason, it may be profitable to install a stabilizer on the straight-run gasoline stream to remove the hydrogen sulfide along with propane and lighter fractions.

The straight-run gasoline prepared from Slaughter crude averages from 0.15-0.175 wt. % mercaptan sulfur at 400°F. end point. The mercaptans present in this gasoline are predominantly high boiling and somewhat difficult to remove by the usual regenerative type caustic scrubbing unit. With a typical caustic scrubbing unit such as that now operated by many Mid-Continent refiners, not more than 50% mercaptan removal can be expected. Since it will be almost impossible to charge straight Slaughter crude oil to a typical Mid-Continent refinery, Fig. 1 has been prepared for the purpose of studying the effect of various percentages of gasoline produced from Slaughter crude blended with others of lower sulfur content.

To use this figure, choose the line running diagonally from 0.155% mercaptan sulfur, which corresponds to 100% Slaughter straight-run at 400°F. end point, to a point on the 0% Slaughter straight-run line which represents the mercaptan content of the present straight-run gasoline. Using this line as a base, the per cent of mercaptan sulfur which will be produced from any blend of other gasoline and Slaughter can be directly determined and used as an index for the blending of crudes. The horizontal dotted lines on the chart represent marginal limits of various treating processes. These limits should be used with some caution since equipment design factors may affect these limitations. In many cases the various processes mentioned can be operated at higher mercaptan levels than indicated, but, in general, at higher levels can be expected to present operating problems and require special controls.

It will be noted that, even though caustic scrubbing is assumed to remove only 50% of the mercaptan sulfur, this greatly increases the operating limits of doctor sweetening or copper sweetening units. For example, assume that a Mid-Continent straight-run gasoline containing 0.025% mercaptan sulfur is blended with Slaughter straight-run. Without caustic scrubbing, copper sweetening is not recommended if the percentage of Slaughter straight-run in the blend exceeds 19%. If the Slaughter straight-run is first caustic scrubbed to remove 50% of the mercaptan sulfur present, 57% of Slaughter straight-run can be used in the blend. This indicates that many refiners in this area can utilize present treating equipment if a caustic scrubbing unit is added and a reasonable percentage of Slaughter used.

For concentrations of mercaptan above 0.25%, only catalytic desulfurization or mercaptan extraction processes should be used. Since these processes reduce total sulfur content and increase octane number they will compare favorably with sweetening processes at much lower

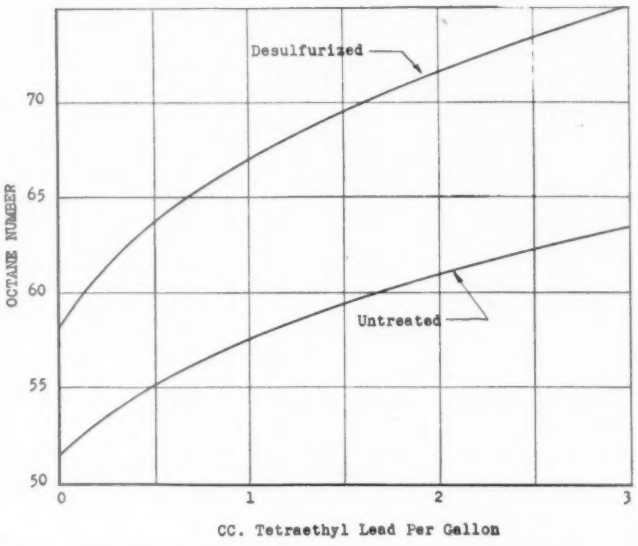


Fig. 7—Effect of desulfurization on lead susceptibility of Slaughter, 400°F. E.P., straight run (Desulfurization conditions: 700° F. 20 lb. 1.0 liquid hourly space velocity, over Silvertown clay. Sulfur reduced to 0.06%)

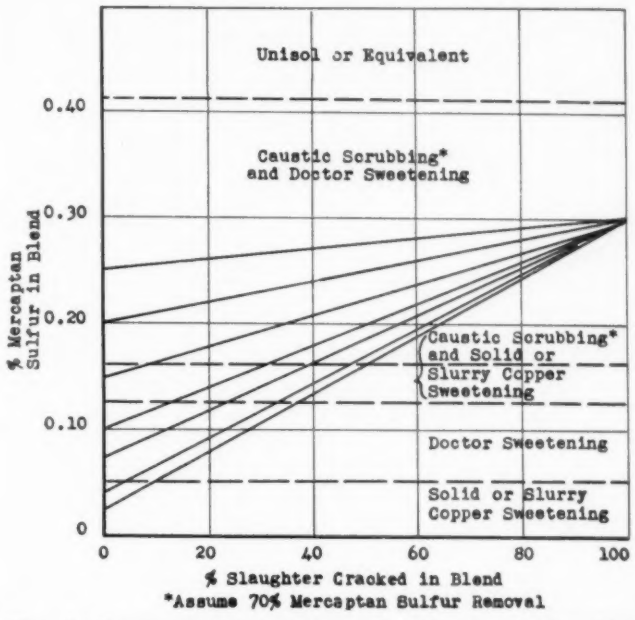


Fig. 8—Recommended treatment for blends of Slaughter cracked gasoline with gasolines having various mercaptan contents

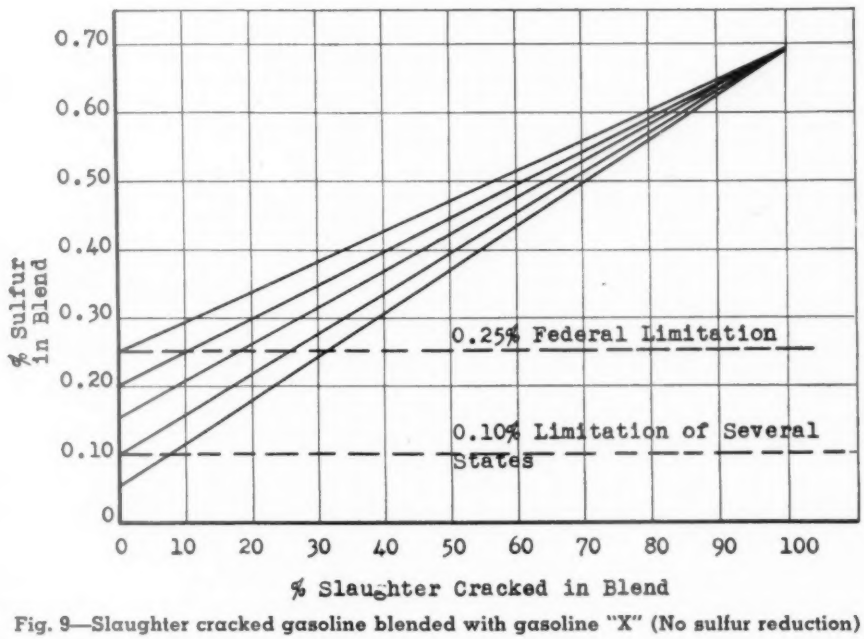


Fig. 9—Slaughter cracked gasoline blended with gasoline "X" (No sulfur reduction)

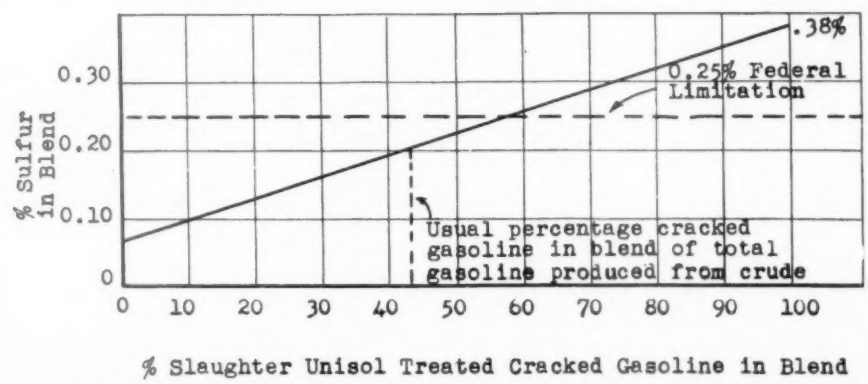


Fig. 13—Slaughter cracked Unisol treated gasoline blended with desulfurized straight-run

levels of mercaptan content. In most cases, these processes can be expected to pay their way even if the mercaptan content is in a low range.

Fig. 2 shows the effect of blends of Slaughter straight-run gasoline upon the total sulfur content of various gasoline blends. It can readily be seen from this chart that since the total sulfur content of Slaughter straight-run gasoline is approximately 0.32%, a reasonable percentage of low sulfur gasoline must be blended with it in order to meet the Federal limitation of 0.25% on total sulfur content. Very little Slaughter can be used if it is necessary to meet the 0.10% limitation of several states.

If caustic scrubbing is used, the total sulfur content is reduced to 0.240%, which is slightly below the Federal limitation. This is shown graphically by Fig. 3.

Fig. 4 shows the effect of removing all of the mercaptan sulfur from Slaughter straight-run gasoline.

Fig. 5 shows the effect of catalytic desulfurization with Silvertown clay at 700°F. 20 psi and space velocity 1.0 upon the total sulfur content. It will be noted from this chart that catalytic desulfurization will produce an extremely low total sulfur content gasoline from Slaughter straight-run which easily meets the 0.10% limitation. Since the cracked gasoline produced from Slaughter crude oil is extremely high in total sulfur content, it may be desirable to desulfurize catalytically the straight-run gasoline in order to blend the desulfurized product with the higher sulfur content cracked gasoline in order to meet the Federal limitation of 0.25%.

Fig. 6 shows the effect of Unisol treating on the tetraethyl lead susceptibility

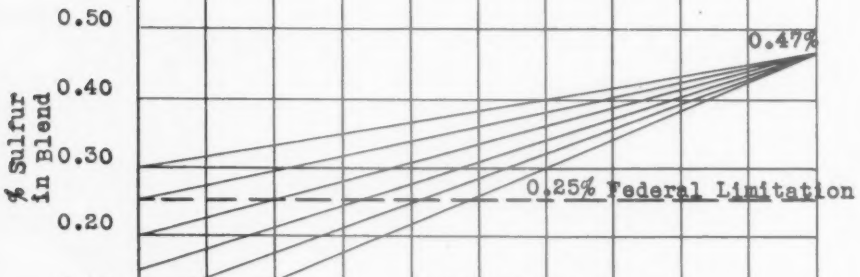


Fig. 10—Slaughter cracked gasoline blended with gasoline "X" (Mercaptan content of Slaughter gasoline reduced 70% by caustic scrubbing)

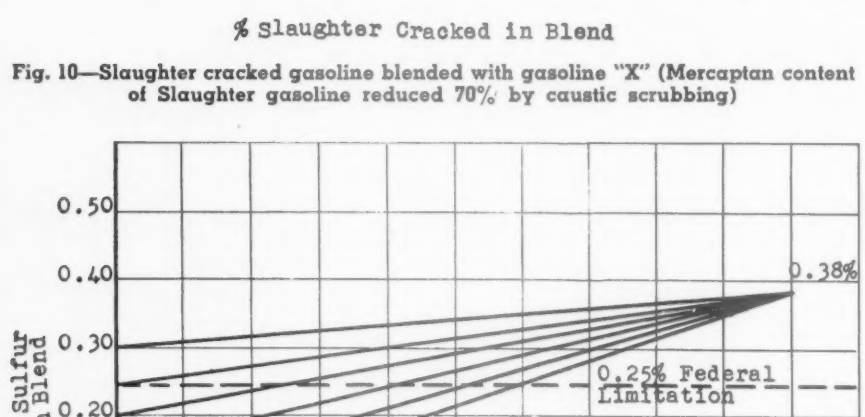


Fig. 11—Slaughter cracked gasoline blended with gasoline "X" (Slaughter gasoline Unisol treated with 100% mercaptan sulfur removal)

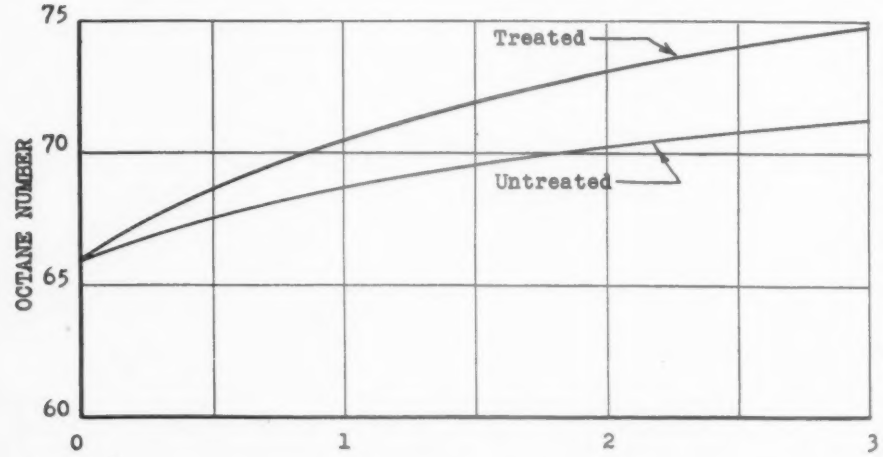


Fig. 12—Effect of Unisol treating on lead susceptability of Slaughter 400° F. E.P., cracked gasoline

of Slaughter straight-run gasoline.

Fig. 7 shows the effect of catalytic desulfurization on the tetraethyl lead susceptibility of Slaughter straight-run.

With reference to Figs. 6 and 7, it should be pointed out that, in many cases, the usual sweetening processes decrease the octane number of the gasoline. Identical samples were not used to obtain the data from which Figs. 6 and 7 were prepared. Although both these samples were 400°F. end point Slaughter straight-run, the untreated clear octane numbers were not the same. This was attributed to a difference in the boiling range of the light fractions.

The kerosine produced from Slaughter crude oil is high in aromatic and total sulfur content. Lamp quality kerosine cannot be produced from this crude oil unless unusually severe treating methods are employed. Kerosine suitable for stove oil can be produced from Slaughter crude by acid treatment or high temperature desulfurization.

Although high in total sulfur content, satisfactory burner distillates can be produced from this crude. It may be desirable to market a maximum quantity of this material as burner distillate and by so doing conserve the quantity of low sulfur oils available as charging stock to the cracking units.

Cracking

From the standpoint of processing there are no particular operating problems involved in cracking Slaughter crude oil. Corrosion rates, however, are extremely high and extensive use of corrosion resistant alloys is required to prevent rapid depreciation of equipment. The addition of lime is an effective method of reducing corrosion rates in cracking equipment. The amount of lime which can be added is usually dictated by the B. S. and W. content of the fuel oil. The usual quantity of lime which is added to a topped crude oil of this sort is approximately 0.5 lb. per bbl. It is recommended that cracking unit heater tubes and headers be constructed of 8% chrome steel. Alloy linings are required in the larger vessels and 11-13 chrome steel is preferred for this service. Gannister linings can be used in some of the larger vessels but these linings have a much shorter life. In all cases where temperatures between 650° to 850°F. are encountered, high corrosion rates can be expected unless special alloys or linings are used.

The cracked residuum will be high in sulfur content but otherwise entirely suitable as a heavy fuel oil.

The cracked gasoline should be immediately stabilized to remove hydrogen sulfide. If the cracked gases are charged to codimer units these are usually equipped with a depropanizer which will remove hydrogen sulfide along with propane and lighter fractions. The bu-

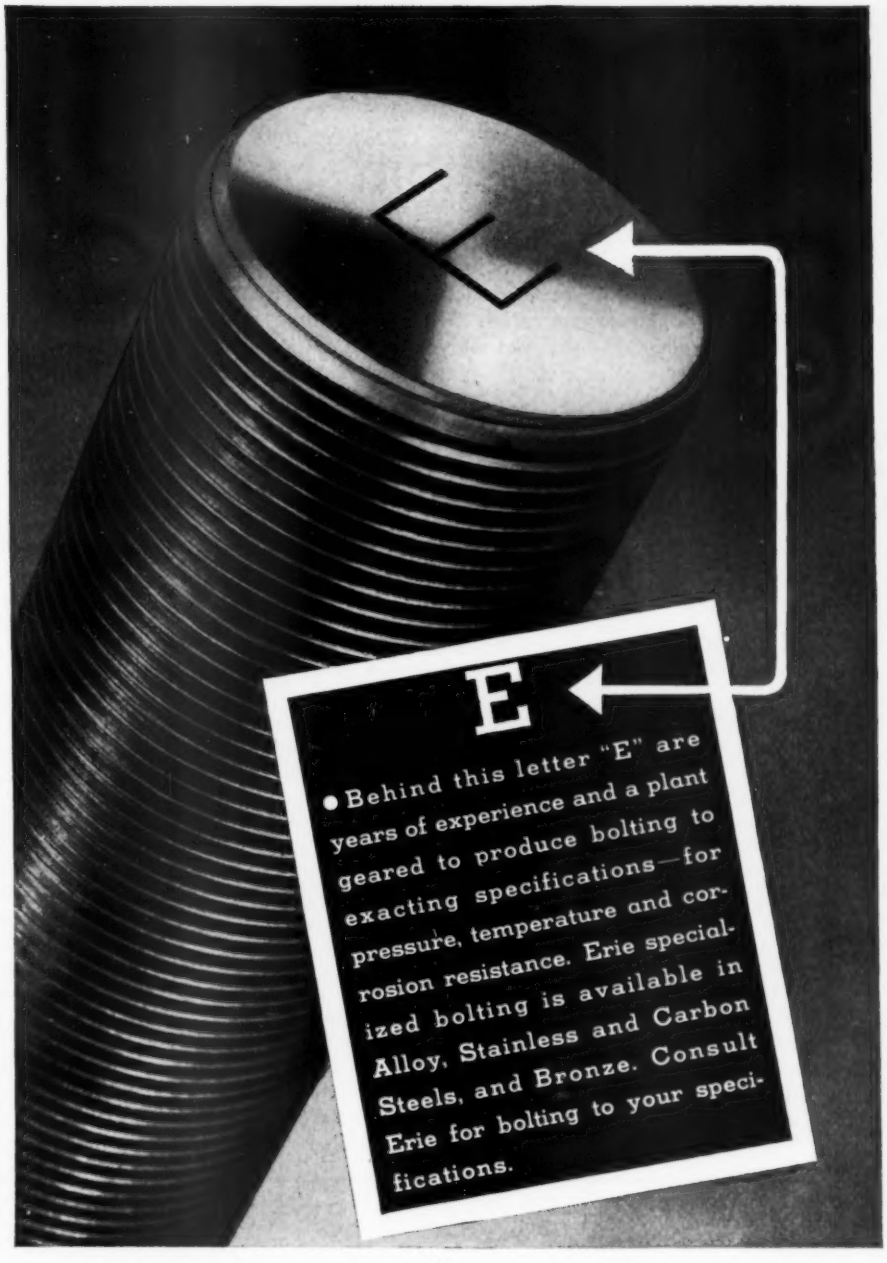
tane-butylene charge to the codimer unit will contain a considerable amount of light mercaptans and it may be necessary to remove these by caustic scrubbing.

If the light cracked gases are charged to a polymerization unit for the purpose of producing polymer for motor gasoline, a depropanizer cannot be used for the purpose of hydrogen sulfide removal without also removing propylene which will materially reduce the amount of polymer produced. In this case it is recommended that one of the regenerative type hydrogen sulfide removal processes such as the Tripotassium phosphate process of the Shell Co. or the Girbotol process of the Girdler Corp. be used.

The cracked gasoline is extremely high in mercaptan content. A commercial unit now operating on 100% Slaughter crude oil produces a cracked gasoline containing 0.30% mercaptan sulfur. As an example of how difficult this might be, in a process in a typical refinery operating a doctor sweetening unit, assuming 1000 b/d was charged to the doctor sweetening unit, it would be necessary to regenerate 2750 lbs. of litharge per day. This would require enormous doctor regeneration facilities to say nothing of the problem of adequately mixing doctor solution and gasoline or recovering the lead sulfide. Figs 8, 9, 10, 11 and 12, were prepared to show the effects of various percentages of Slaughter cracked gasoline blended with gasoline of a lower sulfur content. The charts are similar to those previously mentioned for straight-run gasoline and need no further explanation.

Catalytic desulfurization such as represented by the Phillips bauxite process or the Gray high temperature clay treating process is not generally recommended for cracked gasoline which is to be sold as ordinary motor fuel. First, catalyst life is very short in this service; and second, the distribution of the sulfur compounds present is not favorable to this method of processing. Cracked gasolines predominate in mercaptans and ring sulfur compounds. Catalytic desulfurization has little, if any, effect upon the ring sulfur compounds and although this method of desulfurization will remove the mercaptans, these can be extracted from the gasoline by less costly processes.

If the straight-run from Slaughter crude oil is catalytically desulfurized and the cracked gasoline is Unisol treated to remove all of the mercaptans present, the two products can be blended as produced from the crude oil and a final blend obtained which contains less than the 0.25% Federal limitation on total sulfur. This is shown in Fig. 13. These methods of processing make it possible at a reasonable cost to meet this limitation without resorting to expensive and wasteful acid treating. The saving in tetraethyl lead which results from the use of these two processes will ordinarily be sufficient to permit the rapid retirement of the initial installation cost of the equipment.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R-169

Improved Refining of Sour Crudes By New Tannin Solutizer Process

An improvement of the Solutizer process for removal of mercaptan sulfur from gasoline is described. The development includes the use of an additional promoter and simplifies the regeneration step. Operating costs are less than with the original process, tetraethyl lead savings are comparable and the increase in the value of the treated product is larger.

By H. N. La Croix*

DURING 1940 and 1941 a wealth of material was published on the extraction of mercaptan sulfur from hydrocarbons. The great improvement in tetraethyl lead susceptibility and blending value of gasoline that resulted from the removal of sulfur constitutes one of the outstanding contributions to the industry.

Many data were presented showing the relative solubility coefficient of the mercaptans in caustic soda, particularly the influence of molecular weight which retarded extraction of the mercaptans as the number of carbon atoms increased and as the molecular configuration became more complex. It was noted that removal of mercaptans having more than four carbon atoms, particularly branched carbons, (e.g., iso, secondary or tertiary Butyl) was not practical with ordinary caustic soda solution.

*Design Engineer, Petroleum Division, Foster-Wheeler Corp.

The addition of solubility promoters, called "Solutizers", greatly improved the extraction coefficient of the mercaptans, particularly the higher molecular weight forms. Butyl mercaptans became as easily removable as methyl or ethyl mercaptans.

In the Solutizer process, mercaptan sulfur was removed by simple processing which combined an extraction system to contact the gasoline and a regeneration stage to separate the extracted sulfur oil. This regeneration was accomplished by stripping with steam. Conditioning of the gasoline charge for the removal of the extraction solution contaminants, i.e., hydrogen sulfide and/or organic acids, was also included.

In a typical plant of 12,000 to 15,000 bbls. per day capacity, gasoline was treated for removal of 0.09% mercaptan at an operating cost of 01.25 to 01.5c per barrel charged for all utilities, labor, supervision, and chemicals. Simultaneously, a product appreciation of 0.27 and 0.90 ccs. of tetraethyl lead per gallon was obtained respectively when finishing to 75 and 80 octane numbers (ASTM Motor Method). Net earnings over direct operating cost ranged from 1 to 6c per barrel, creditable to plant payout.

Prior to Pearl Harbor, the Solutizer process was under active consideration by many refiners as a means of improving the quality of their gasolines while providing a better means of finishing their product. However, war priorities and the necessity of increasing production of aviation grade fuels stopped further development and building for this and similar processes. High nickel alloys for heat exchangers were impossible to secure.

Two Current Factors

Two factors have of late contributed to the re-emergence of Solutizer processing as a pertinent issue today. One has been the necessity for utilizing sour crudes to buttress our diminishing oil reserves; the other the New Tannin Solutizer process developed by the Socony-Vacuum Oil Co. and the Shell Development Co. and recently released to refiners under Socony-Vacuum and Shell patents.

This process incorporates the use of an additional promotor or catalyst and considerably simplifies the regeneration step. Restrictions do not permit disclosure in this paper of the detailed op-

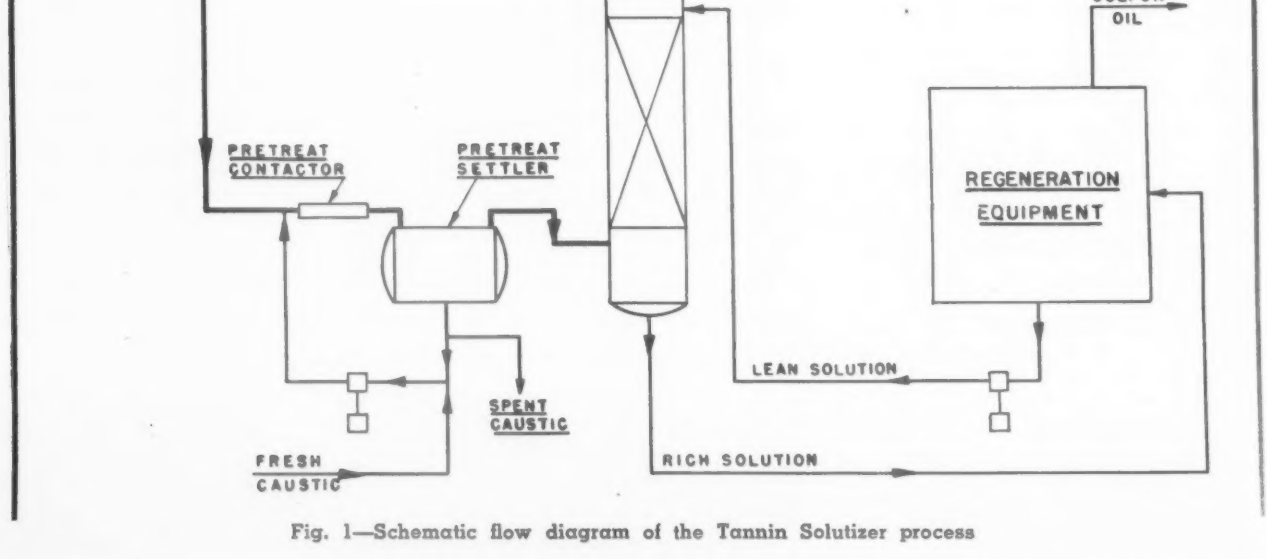


Fig. 1—Schematic flow diagram of the Tannin Solutizer process

eration of the regeneration, but the information is available to responsible parties. A schematic flow diagram, Fig. 1, illustrates the basic steps in the process. These are similar to the original Solutizer process; namely, (1) conditioning the feed by hydrogen sulfide and/or organic acid removal, (2) contacting the hydrocarbon with Solutized caustic, (3) separation of the purified product from the extraction solution, and (4) regenerating of the solution prior to recirculation.

Improvements made in the extraction solution and in its regeneration have substantially reduced direct operating charges. Operating costs for a charge stock of similar composition to that mentioned previously and containing the same amount of mercaptan sulfur to be extracted, would be 0.4 to 0.5c per bbl. This represents a reduction of approximately two-thirds for costs of utilities, labor and supervision, and chemicals. The tetraethyl lead savings are comparable to those effected in the unit of older design; net earnings per barrel of gasoline are 1.75 to 7c per barrel, applicable to plant payout.

Plant Investment Cut

Plant investment costs have also been reduced as a result of the simplification in the method of regeneration. This saving amounts to approximately 15% of the total plant cost over the former design. Less critical materials are involved, and no special alloys are needed. In cases where doctor sweetening plants are in good condition, addition of regeneration equipment and modification of the treating section may be effected for application of the new process.

The Tannin Solutizer process presents advantages to refiners faced with refinery changes involving substitution of West Texas or high sulfur crudes for sweet crudes which were being processed. There are no limits to the amount of mercaptan sulfur which may be removed. There is no formation of excessive amounts of water nor do complex side reactions result. As with any extractive operation, reduction of mercaptan sulfur is dependent only on rate of solution circulation and degree of regeneration.

Advantages Summarized

The Solutizer process offered the following advantages for the refining of gasolines from sour crudes:

1. Removal of mercaptan sulfur and reduction in total sulfur content.

2. Increased tetraethyl lead susceptibility and consequent savings in tetraethyl lead.

3. Improved octane numer and blending value.

4. A simple, regenerative extraction operation without need for careful control to avoid formation of undesirable and complex side reaction products.

5. Replaced a refining cost operation by a profitable finishing process.

The New Tannin Solutizer process incorporates the above and adds these improvements:

A. Reduces direct operating costs by two-thirds.

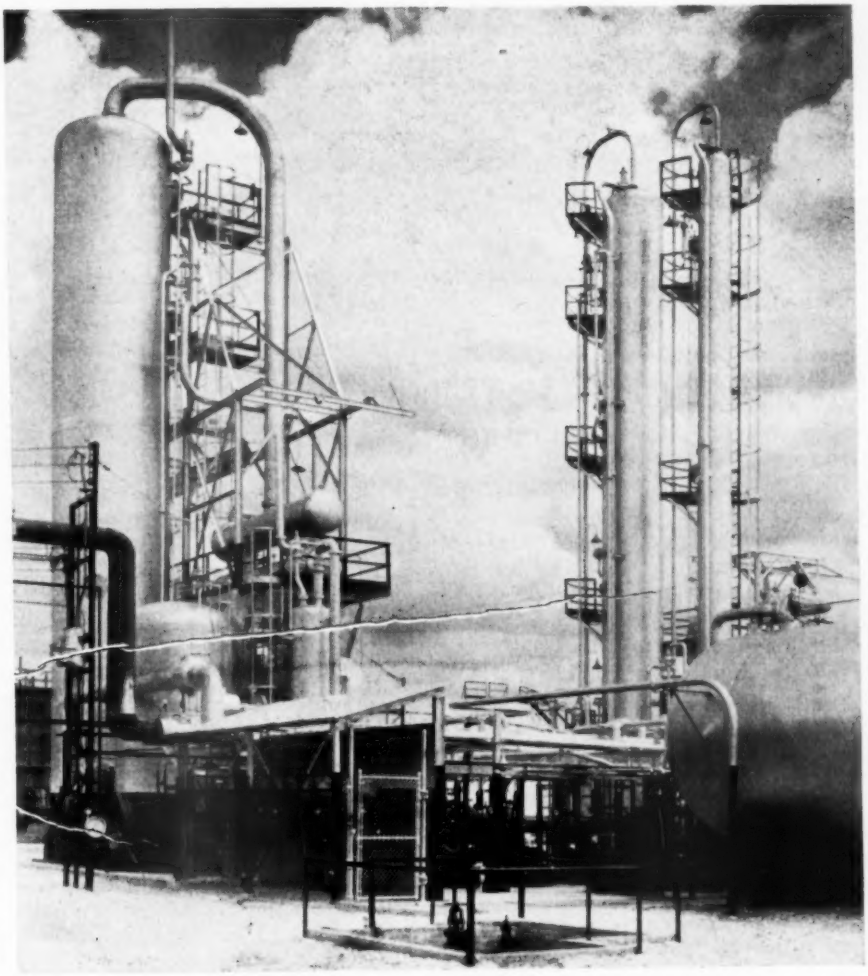
B. Reduces investment cost by 15%.

C. Precludes the need for special alloys.

D. Recovers the sulfur oil in an easily handled and profitable form.

E. Presents a process sufficiently low cost to permit treating even butane-butylene feed stocks.

Two plants employing this process are now being built by Foster Wheeler for a combined capacity of 44,500 b/d. They will operate on gasolines from Mid-Continent and West Texas crudes. Plants are operating now on both the old and new process methods. Some Solutizer solutions have been in successful use for over three years.



Solutizer plant of the Shell Oil Co. at Houston, Texas: capacity 28,000 b/d

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Are Nine Weights or S.A.E. Grades Of Motor Oils Justified?

Sales Analysis Indicates Elimination of Certain Grades Would Provide Economies in Distribution and Refinery Operations, and Motorists' Needs Would Be Fully Met

Refinery shipments of motor oils and field warehouse inventories were analyzed for a territory with wide seasonal climatic changes. Based on data disclosed, the S.A.E. 60 and 70 grades were eliminated from the premium line without disturbing the sales volume. The 10 W and SAE10 and 20 W and SAE 20 premium grades were combined into two grades, of satisfactory pour point and viscosity index. Sales analysis data of this type has also been found valuable in estimating monthly requirements of bright stock and neutrals at blending plants.

*By VICTOR I. DOWNEY**

THE decision of those responsible for writing lubricant specifications for the Armed Forces to adopt the practice of using only three grades or S.A.E. numbers of motor oils would seem to justify the stand of many technologists. They have maintained for years there was no good reason for any company carrying nine weights of motor oils on its shelves, (10W, 20W, SAE 10, 20, 30, 40, 50, 60, 70). Unfortunately, however, many who are responsible for guiding the sales policies of their companies are not too sympathetic with sales research, to say nothing of technical research.

It has always seemed fairly obvious to the technologist especially for the last eight years, that there could be no real scientific basis for the assumption that in the U. S. there is a climatic variation that requires such a wide variation in viscosity of motor lubricants. It seemed still more unlikely that, with the great standardization of vehicles and the tendency toward regular "trade-ins", there could be such a variation in demand.

Data collected over several years for the purpose of guiding refinery operations are interesting when considered in the light of actual sales demand versus demand as assumed to be valid by the sales forces.

The data to be presented represents actual refinery shipments and not actual sales. It will be shown that actual refinery shipments are not a correct measure of sales. The sales of the company represented by these figures cover the entire field from service stations through bus and truck fleets and to the farm trade. It is, therefore, evident that this is a balanced industry picture. The territory involved is the so-called "heart section" of the U. S. as shown in Fig. 1.

For the purpose of securing the broadest possible picture, the shipments of a so-called house brand motor oil in the 25-30 cent-per-quart bracket have been studied over the years 1935 to 1943 inclusive. The actual percentage shipments of each S.A.E. grade are listed in Table 1.

Since it seems easier to follow any trend graphically rather than by the use of tables, the trends of shipments of the various weights of oil over the nine-year period under study are shown in Fig. 2.

A rather startling fact brought out by this study is the very small percentage of shipments in the S.A.E. 50, 60 and 70 classifications. When confronted by these figures and the suggestion that these three weights be dropped, the usual answer seems to be that, while the figures seem small, the total of the three weights amounts to about 2½% and that a loss of this volume or even half of it is not to be lightly assumed.

Fig. 1—Territory for which motor oil sales were analyzed

With this type of an answer from the sales department, it was decided to look further into the reason for the small volume and see if some more convincing argument could not be found.

Inventories Studied

The next step was to study year-end inventories in the field warehouses. Further evidence of the failure of the heavy grades to move to the trade was found in the fact that a relatively large amount of the heavy grades was found in that class of merchandise classified as "old or slow moving stock." In many cases the warehouses had been cleared by so-called sales of "obsolete" brands or "excess" stocks.

A study of the records resulted in the further discovery that many requests had been made of the technical department for information as to how much S.A.E. 10 would be necessary to reblend the three heavy grades into the heavy movers, S.A.E. 20 and S.A.E. 30. It was evident that this procedure had been used in many cases to clear the inventory. This fact then proved that actually the sales of the three heavy grades were much lower than the percentages in Table 1. Carrying this reasoning further, it means that, since a part of the shipments of S.A.E. 10 were used in blending, the actual sales of S.A.E. 10 were less than indicated in this table and the sales of S.A.E. 20 and 30 were greater than shown.

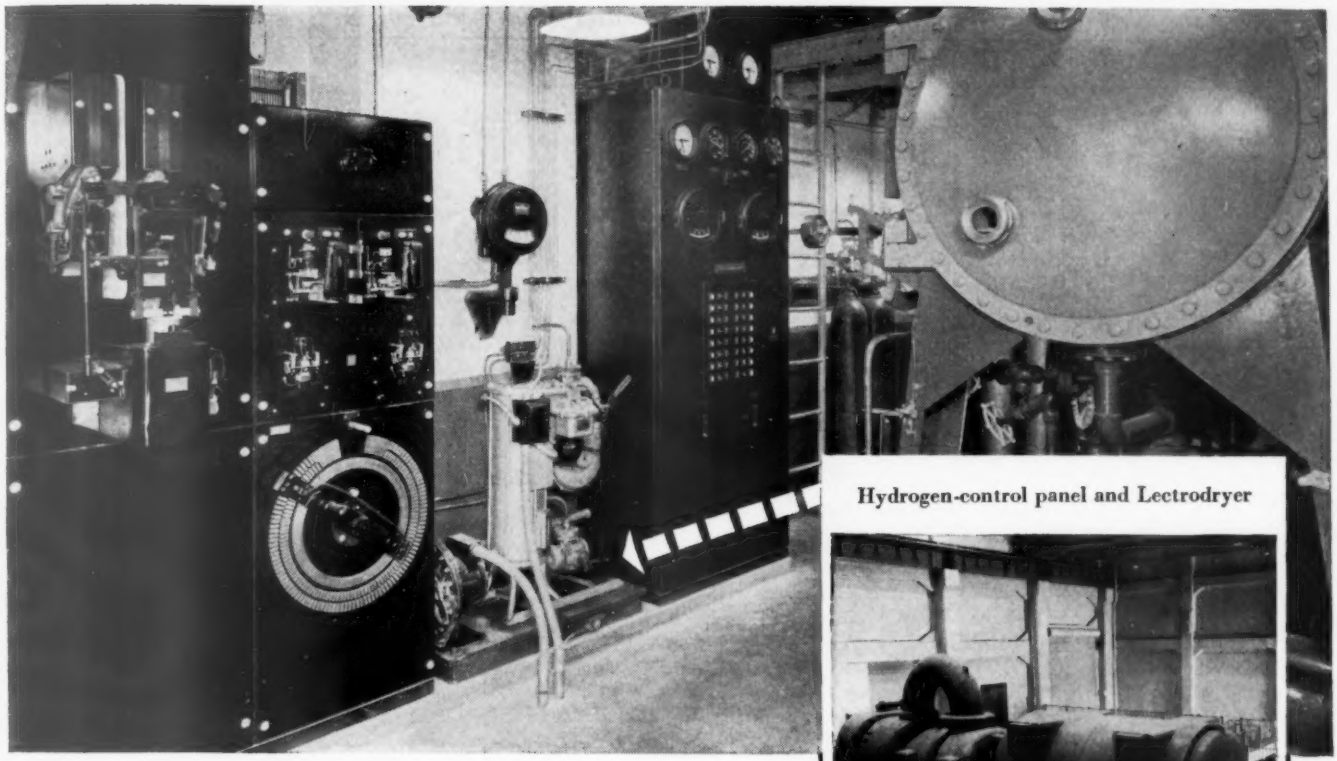
With these figures established, a start was made in 1942 and grades S.A.E. 60 and 70 were eliminated from a line of Pennsylvania Emblem oil sold in the 30-35 cent-per-quart bracket without any difficulty. The sales volume on the whole showed a healthy increase and no accounts were seemingly disturbed by the fact these grades were no longer available. It was felt, however, that technically the line was still top-heavy with seven weights, (after elimination of S.A.E. 60 and 70) and a further attempt

Table 1—Percentages of Nine S.A.E. Grades of House Brand Motor Oil Shipped from Refinery, 1935-1943

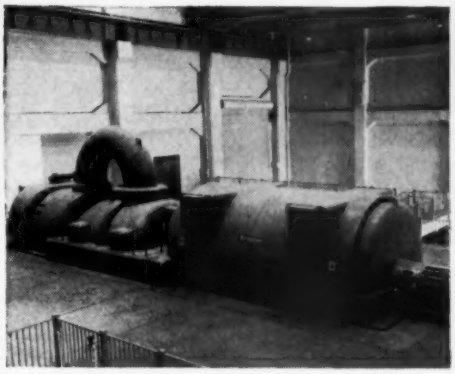
Year	1935	1936	1937	1938	1939	1940	1941	1942	1943
GRADE									
10 W	5.62	8.34	6.31	5.35	5.56	6.97	5.23	3.62	3.07
20 W	10.87	9.17	7.03	7.04	7.65	6.28	5.49	4.09	5.89
S.A.E. 10	2.07	3.92	5.19	5.37	6.31	6.61	8.41	7.71	6.57
S.A.E. 20	13.76	16.42	18.39	19.55	20.79	21.02	23.45	23.36	25.62
S.A.E. 30	30.72	30.98	34.37	37.78	37.18	34.57	35.08	37.10	39.23
S.A.E. 40	23.53	22.12	22.12	20.95	19.07	20.72	19.37	20.91	17.05
S.A.E. 50	10.20	6.14	5.03	3.20	2.83	3.10	2.39	2.64	1.72
S.A.E. 60	2.95	2.52	1.37	0.66	0.52	0.62	0.41	0.32	0.29
S.A.E. 70	0.27	0.38	0.18	0.09	0.08	0.08	0.15	0.20	0.15

Note: Since the figures are only carried to the second decimal point the totals will not equal 100%.

*Technical Co-ordinator, National Refining Co., Cleveland.



Hydrogen-control panel and Lectrodryer



82,500 kva. hydrogen-cooled generator, Dept. of Water & Power, Los Angeles

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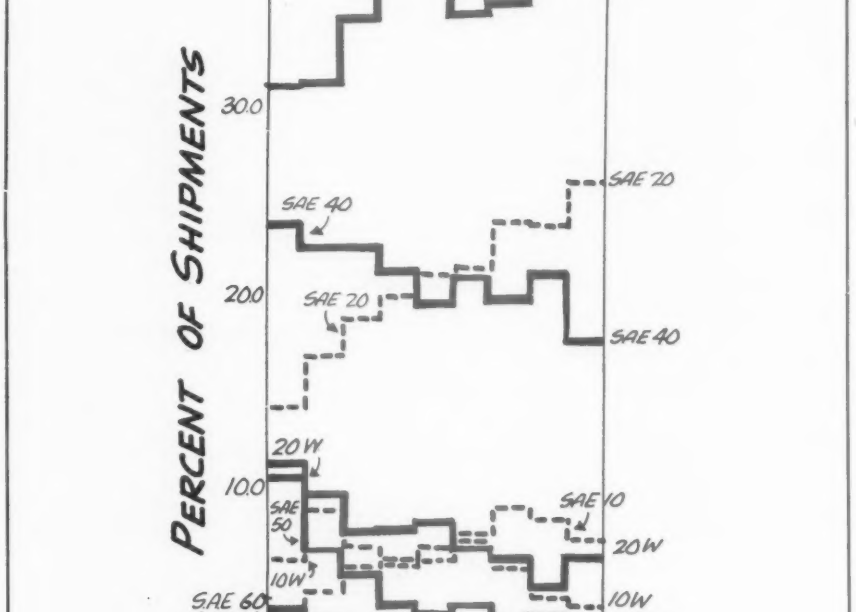

Fig. 2—Trend of shipments of 9 S.A.E. grades of motor oil, 1935-1943, into sales territory with wide seasonal climatic changes

was made to reduce the grades in number.

The Pennsylvania Emblem oil was again made the guinea pig because of its versatility. It was argued that with an oil of such a high viscosity index there was no real need for a 10 W and a S.A.E. 10, and similarly a 20 W and S.A.E. 20. It was decided to make a combination 10 W/S.A.E. 10 which by reason of low pour point and high viscosity index could be properly branded as being within the accepted trade limits of both grades. The same step was taken with 20 W and S.A.E. 20. The results of these changes are shown in Table 2.

It will be noted that the combined percentages of 10 W and S.A.E. 10 in 1940 totaled 28.89% as against 25.34% in 1941. Similarly the combined 20W and S.A.E. 20 shipments totaled 35.2% as against 38.26% in 1941.

It would seem from the above figures that it should be feasible from a sales standpoint to eliminate four grades from the line. The S.A.E. 50 figures indicate that this grade could well be eliminated also. This would leave only four grades to be warehoused and delivered. From the standpoint of the production manager or superintendent of the blending and packaging plant, such a move would pay dividends.

The combination of 10W and S.A.E. 10 grades and the 20W and S.A.E. 20 grades would seem to be a goal much to be desired by the refiner or blender. With added capacity of extracted oils after the war it would seem that this move should be planned now. If a refiner has S.A.E. 10 and 20 grades available at 90 V.I. or higher, it would only be necessary to dewax to a point satisfactory for the W line or to add extra pour point depressant. For the most part the desirable higher viscosities of the S.A.E. 10 and 20 grades could be retained.

It seemed also to be desirable to determine if possible whether the same percentage ratios of the various S.A.E. numbers carried through the various price brackets. With that in mind the shipments of oils in four price brackets were compared. The results of this study are shown in Table 3.

The data in this table bring out several points which are apparently related to the buying habits of the public.

It would appear that the large percentage of sales of 20W/S.A.E. 20 grade, in the case of the Pennsylvania Emblem oil, is related to the ability of the oil to permit ready winter starting and perhaps to the adherence of this type of buyer to a regular oil change schedule.

In the case of the so-called house brand type of oil there is a seasonal shift in the weight of oil used. (20W in winter and S.A.E. 20 in summer).

It is interesting to note, however, that the S.A.E. 30 is the largest seller throughout all four price brackets.

It should also be noted that there is an increase in consumption of S.A.E. 40 in the two lower price brackets. This is attributed to the tendency to increase the weight of oil used as the car gets older and to offset increased consumption by the use of heavier and cheaper oils.

There was found a decided tendency to dispense with regular oil changes in the case of older cars and to merely "add

Table 2—Percentages of Shipments of Emblem Grade Pennsylvania Motor Oil 1940-1943, Showing Results of Eliminating Two Grades and Combining Four Others into Two Grades

Year	1940	1941	1942	1943
GRADE				
10 W	13.89	.....	.....	.....
20 W	8.88	.....	.....	.....
10W/S.A.E. 10	.....	25.34	19.24	18.13
20W/S.A.E. 20	.....	38.26	36.44	32.33
S.A.E. 10	15.00	.....	.....	.....
S.A.E. 20	26.32	.....	.....	.....
S.A.E. 30	26.71	28.86	33.05	39.89
S.A.E. 40	7.64	6.79	10.82	9.49
S.A.E. 50	1.30	0.41	0.43	0.15
S.A.E. 60	0.16	0.33	.....	.....
S.A.E. 70	0.09	.....	.....	.....

Table 3—Comparison of Shipments of Various S.A.E. Grades by Price Bracket

Price Bracket c per Qt.	S.A.E. No.	1940	1941	1942	1943
			Percentage of Shipments		
30-35	20/20W	35.20	38.26	26.44	32.33
25-30	20 only	21.02	23.45	23.36	25.62
20	20 only	17.89	16.30	19.57	20.92
15	20 only	21.50	21.30	24.45	24.30
30-35	30	26.71	28.86	33.05	39.89
25-30	30	34.57	35.08	37.10	39.23
20	30	38.30	40.50	39.22	39.20
15	30	33.20	35.20	33.24	33.92
30-35	40	7.64	6.79	10.82	9.49
25-30	40	20.72	19.37	20.91	17.05
20	40	24.50	25.10	23.32	24.75
15	40	27.60	26.20	18.73	26.05

to." This tendency was not entirely recognized by the sales staff until after the decision was made to package the 20-cent oil in one-and-five-quart cans.

When the order for cans was placed the ratio of five quarts to one quarts was based on the experience with the Pennsylvania Emblem oil and the house brand grade and the same proportions were ordered. The warehouses were stocked and the matter was forgotten for a matter of two years when the blending plant superintendent called attention to the fact that a great proportion of the original shipment of five quarts was still on hand, empty. A quick check-up revealed that the type of buyer to which the 20-cent canned oil appealed did not purchase an oil change but bought one or two quarts "to bring the level up."

Sales Figures Helpful

The figures given in the above tables have been of considerable value to those responsible for estimating the monthly requirements of bright stock and neutrals at the blending plants. By converting the various figures into bright stock and neutral and striking a weighted average it is possible to secure a very accurate percentage for budget purposes.

As an example for the year 1940 in Table 1 the bright stock percentage was 22.6% for the whole year, and for the year 1941 the percentage was 22.2%.

It can be seen from the data cited herein that sales figures can be technically analyzed to a very good advantage. It is submitted that many errors of judgment in arriving at sales policies and programs could be eliminated by the use of such procedures. It is further recommended that serious consideration be given to the elimination of at least the grades S.A.E. 60 and S.A.E. 70.

How To Write a Report On a Research Project

"Technical Report Writing", by Fred H. Rhodes, fills the need of both students and graduate technologists in the field of chemical engineering for a thorough book on the subject of preparation of reports in investigative work.

It points out briefly the importance of effective presentation in technical reports and indicates the characteristics of a good report. Separate chapters deal with the organization and form of the technical report, and a short chapter on style, conventions, and correct usage calls attention to common errors. The book also deals with some of the simpler methods of analyzing, correlating, and depicting experimental data, and a bibliography is given for a more detailed discussion of these topics.

"Technical Report Writing," contains 125 pages, sells for $1.50, and may be purchased through the Book Department of National Petroleum News, 1213 W. 3d St., Cleveland, O.

Comment on Article on Design Of Anchor Bolts for Towers

Dear Editor—

In the Jan. 5, 1944 Technical Section under the caption "Design of Anchor Bolts for Stacks and Towers" by E. F. Brummerstedt, certain conclusions are reached with which we feel the author has not taken his own conclusions into account.

The center of pressure of a stack without moment is the center of the stack. As the moment is applied the center of pressure moves leeward, passing a phase when the forces are in equilibrium around the center line, which is the condition for the design with the section modulus method. In the problem given this gives an extreme bolt tension of 93,000 lbs., but a compressive stress in the concrete of 650 psi.

The author then proceeds to go further; the condition of maximum concrete value of 1000 psi is assumed as acting. This allows a longer lever arm and results in an extreme bolt tension of only 64,200 lbs., which is the condition of extreme toe pressure on the concrete.

However, before this final condition can be reached, the center of pressure must move through the phase of having the neutral axis at the center line of the stack, which gives the higher bolt tension. The bolt size should, therefore, be determined by this maximum stress rather than by the concrete stack analogy, unless the writer is willing to assume a temporarily high unit value for a condition which exists in passing to the high concrete toe pressure which has been assumed.

In recent designs of two 200-foot and one 100-foot stacks, we have not been willing to reconcile the concrete stack analogy theory for the reasons stated above. We would be interested in learning how the author has the center of pressure reach the position at "C", center of compression, without passing through the phase as noted above.

WALTHER J. WEFEL
Architect and Engineer,
Cleveland, Ohio

Author's Reply:

As Mr. Wefel states in his comments, the center of compression moves from the stack's center, its position without moment, to leeward as the wind pressure is applied. At the instant when the resisting couple is in equilibrium around the center line of the stack, the wind moment has not yet reached the maximum for which the base was designed, and the resisting moment, as well as the component stresses of the bolts and concrete, are not yet at a maximum. The position of the theoretical neutral axis is determined by the intensities of the resisting forces balancing about it in accordance with the well established ratio "n" of the moduli of elasticity for steel to concrete. The resisting couple could not be in balanced equilibrium about the center line during the application of the maximum design moment without changing the ratio "n."

Mr. Wefel apparently bases his objection to the concrete stack analogy theory to an assumed short interval of time between the application of the moment and the corresponding movement of the neutral axis. This interval, if it exists, must obviously be very small in order not to violate conditions of static equilibrium. It certainly cannot be appreciable for ordinary wind storms, where the pressure increases gradually; only in the event of a theoretically instantaneous impact of maximum force could it have any effect. This is practically impossible for a wind moment; for an earthquake moment it is more likely, but in that case the static moment method of calculation is considered more conservative by the Los Angeles Board of Reviewing Engineers than any one of several dynamic methods based on simple harmonic motion, which have been developed as a result of study of certain seismic failures.

Therefore, the writer maintains that to design anchor bolts on the basis of the neutral axis coinciding with the center line is not only ultra-conservative but theoretically incorrect based on conditions of static equilibrium. If it were correct, then, to be consistent, the reinforcing steel in a concrete stack or beam proper would also have to be designed accordingly; but that would be contrary to all accepted theory and practice. Actually, failure of an anchor bolt is extremely unlikely except as a result of severe corrosion or weakening by initial overpulling beyond the elastic limit.

If a moment far in excess of the design conditions were applied and overturning resulted, it would probably be due to bond failure or crushing of the small area of the foundation pedestal, remaining in compression, since concrete does not follow Hooke's law, but has a variable modulus of elasticity which decreases with an increase in stress. In practical design, to compensate for this, it is usually given a lower modulus than that obtained from compression tests under small stresses, specifications varying from 1/10 to 1/15 that of steel.

E. F. BRUMMERSTEDT

The Corrosion and Stability Test For Lubricating Oils*

The importance is recognized of evaluating the tendency of an internal combustion engine lubricating oil to become corrosive in service through the corrosion of the bearing metals and alloys in the engine. A new method, by the use of the corrosion and stability apparatus, provides a means for determining the "potential corrosivity" of the lubricant by promoting its oxidation characteristics.

An important feature of the apparatus, which is described in detail, is a means for wiping the bearing. This simulates the action of the journal in an engine which prevents the accumulation of the products of corrosion; thus making the test conditions more comparable to those of an oil in service. The effect is discussed of changing such variables in the apparatus as temperature, time, degree of agitation, rate of air flow and other conditions is discussed.

Part 2, to be carried in a succeeding issue, presents data showing the extent of correlation obtained between the results of the Corrosion and Stability test and actual engine performance.

*By George W. Waters**, Elder C. Larson** and Ben Borus***

Part 1

IT IS universally agreed that the ultimate criterion of the quality of a lubricant is efficient performance in the engine for which it is designed. This fact will likely remain permanent, since bench-methods inevitably lead to departures from the actual engine. It is scarcely possible that accurate reproduction of an engine in its entire scope will ever be realized in a non-combustion type of laboratory apparatus.

The corrosion of the bearing metals and alloys of an internal combustion engine by the lubricating oil occurs in service under conditions which effect simultaneously other chemical changes in the lubricant. In general, a fresh lubricating oil contains no corrosive bodies. However, let an oil-metal system be subjected to considerable aging under conditions representative of service, and corrosion will occur to various degrees dependent upon the nature of the oil and the severity of the conditions.

This tendency of an oil to become corrosive, which in the present work is called "potential corrosivity," is defined as the extent of corrosion which will occur during the service life of the oil and is measured as the specific weight loss (milligrams per square centimeter) of a metal or alloy. Potential corrosivity will depend to a major degree upon the conditions to which the oil is subjected during aging. As it occurs in service, corrosion is inseparable from and dependent upon the deterioration of the oil through oxidation. Hence, it is essential in the laboratory to select conditions of test for potential corrosivity which will promote the oxidation of the lubricant.

The existence of many laboratory apparatus and methods of test admits the need for means of evaluating oils which can cope economically and practically with the great bulk of testing required either in the development of improved lubricants or in the control of oils in production. Such service is far too formidable for even small scale test engines. It is generally true that each test in its development was designed specifically to evaluate a particular feature which the originators deemed important and worthy of emphasis. The tests existent prior to the development of the present apparatus represented a wealth of knowledge and experience, from which could be selected the outstanding features, the incorporation of which has led to the development of the Corrosion and Stability (C and S) apparatus.

For example, the use of severe conditions of aging leads to the simultaneous occurrence of oil oxidation and corrosion, a feature of several tests. A large oil charge facilitates determination of products of deterioration and evaluation of oxidation stability, an objective of the Underwood test (14). The use of glass and aluminum eliminates stray catalytic effects and lessens the cleaning problem. The use of a vigorous stirring action in the oil acknowledges a merit common to the Indiana Stirring Oxidation (6) and the MacCoull Corrosion (8) tests. Venting the reaction chamber with air is a feature also common to many tests. Finally, the use of a felt wiping action on the bearing surface, which resembles more closely the earlier technique of Clower (3) than that of the Thrust Bearing Corrosion machine (13), incorporates a feature recently suggested as essential in

Fig. 1—Detail and flow diagram of Corrosion and Stability apparatus

*The material forming the basis for this paper was presented before the Petroleum Division of the American Chemical Society, April 12-16, 1943, Detroit, and has been published in the Industrial & Engineering Chemistry.

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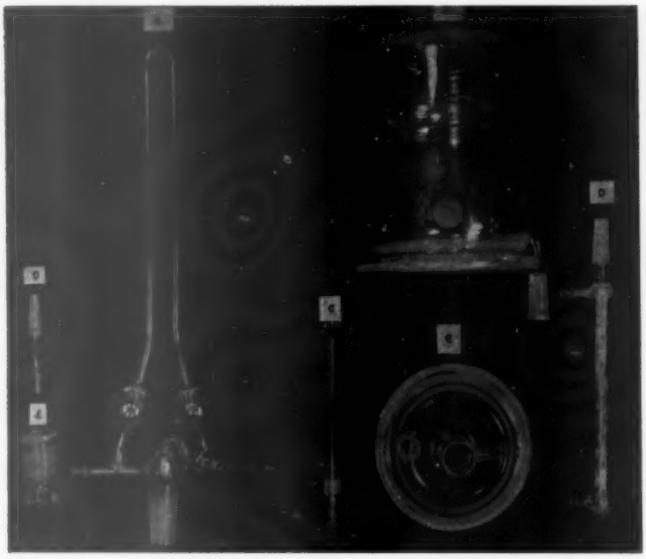


Fig. 2—The C. and S. apparatus: Metal support for reaction chamber removed and rotor raised

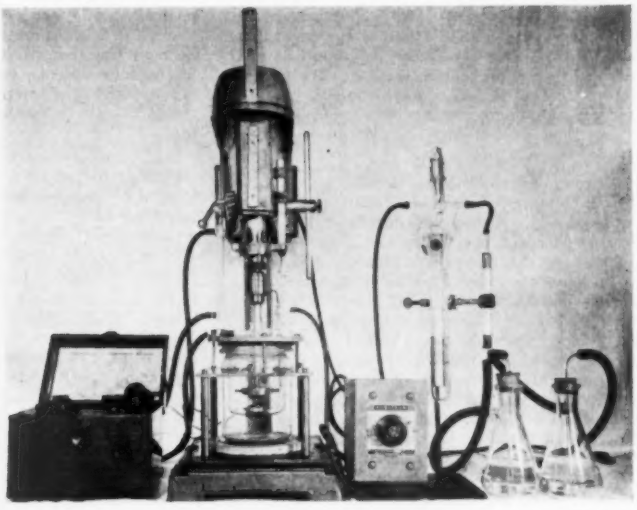


Fig. 3—Glass equipment of the C. and S. apparatus: A, reaction vessel and vapor bath; B, cover; C, reflux condenser; D, combined thermocouple well and air inlet; E, F, G, manometric flowmeter

the accurate evaluation of corrosivity of oils toward copper-lead bearings. In addition, the new apparatus and method of test have been designed to constitute durable, inexpensive means of evaluating in 5 hours the essential characteristics of a lubricant, and hence are amenable to either research or control application.

The Corrosion and Stability (C and S) Apparatus

A major premise upon which the present apparatus and test are based is that it is possible, empirically and artificially, to age an oil in the laboratory in a manner comparable with the aging in service. Rigid control of the important variables, temperature, catalysis, time and concentration of reactants is important to obtain satisfactory reproducibility. Compatible with the above premise, simplicity in design rather than mechanical reproduction of an engine has been sought.

It is recognized, however, that factors, operative and influential in an engine, must of necessity remain extrinsic to a laboratory test; for example, fuel, fuel combustion products, dirt, etc. The correlation between laboratory test and engine is thereby limited, and the necessity of retaining the engine as the final criterion becomes apparent. The degree of correlation which has been obtained between engine performance and the Corrosion and Stability test is sufficient to establish the latter as a useful tool for the preliminary evaluation of lubricants.

Apparatus

The Corrosion and Stability apparatus is illustrated by diagram in Fig. 1 and by photograph in Fig. 2. In Fig. 3 the glass parts of the apparatus are shown dismantled and in Fig. 4 the metal and felt units are similarly illustrated.

For convenience, the apparatus can be divided into four assemblies.

(a) *Reaction Vessel:* (cf Figs. 1 and 3). The reaction vessel is fashioned out of a 1 and a 2-liter pyrex beaker joined at their rims by a ring seal. The space between the beakers, equipped with a reflux condenser, serves as a vapor bath which provides heat and precise control of temperature. The heat medium may be any material which boils at the desired temperature of test. In the bottom of the inner beaker there is a square recess. The reaction chamber is covered by a glass lid, and a seal is effected by a flat ground-glass contact.

The shaft of the aluminum rotor passes through the center of the cover, from which extends a lead to a water aspirator which prevents fumes of deteriorating oil from being dispersed into the laboratory. Displaced to one side is a female ground-glass joint which accommodates a combined thermocouple well and air inlet. Through this opening, samples of oil can be taken, if desired. The over-all volume of the reaction chamber is approximately 850 to 900 ml.

(b) Wiping and Stirring Assembly: (cf Figs. 1 and 4). The aluminum bearing insert holder, which is called the "anchor" (cf Fig. 4C) consists of an aluminum disk with a square protrusion extending from the bottom and a square recess sunk into its top. The square protrusion fits into the recess in the bottom of the reaction chamber and is cushioned by a square felt pad. (cf Fig. 4B). This feature prevents rotation of the anchor during operation. The recess in the top of the anchor accommodates the square bearing insert, the surface of which extends about 0.03" above that of the anchor (cf Fig. 4D).

Four radial holes bored laterally along two perpendicular diameters converge in a larger hole bored coaxially through the anchor. A hole bored perpendicularly through the bearing insert is of the same size and coincides with the

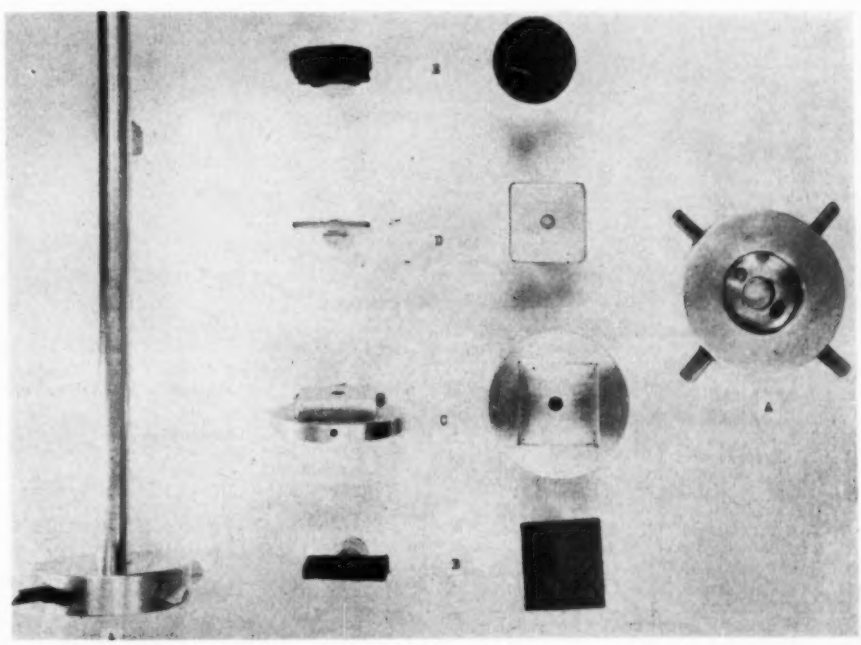


Fig. 4—Metal and felt equipment of the C. and S. apparatus: A, aluminum rotor; B, felt cushioning pad; C, aluminum anchor; D, bearing insert (copper-lead); E, felt wiping pad

one extending coaxially through the anchor. This system of ducts provides a means which, in conjunction with the action of the felt wiping pad, insures an even and continual flow of lubricant over the bearing surface. The bearing inserts can be of any available metal or alloy; copper, aluminum, lead, copper-lead, cadmium-nickel, and lead-flashed copper-lead have been employed.

The wiping and stirring actions are provided by an aluminum-felt unit called the "rotor" (cf Fig. 4A). The rotor consists of an aluminum shaft which is chucked into a conventional, bench-type drill press. Attached to the shaft is an aluminum disk, in the bottom of which is a cylindrical recess placed coaxially with the disk and shaft. Extending from the "ceiling" of the recess are aluminum spikes which imbed themselves in the felt wiping pad (cf Fig. 4E) and prevent its slipping during rotation. The felt wiping pad is fashioned out of a cylindrical pad of felt of diameter such that a snug fit is insured and of sufficient thickness so that it will extend below the surface of the rotor. In general, the nature of the felt used is not critical, if it does not disintegrate during the course of a run. Normally, S.A.E. F3 gray backcheck felt is used; S.A.E. F1 white backcheck has been found satisfactory.

On the face of the pad is cut a pattern represented in the diagram of Fig. 1, and shown by photograph in Fig. 4E. Briefly, this pattern, conveniently cut with a razor blade, consists of two perpendicular, Vee troughs cut along diameters of the surface. In addition, 4 "pie-shaped" pieces are cut from the 4 sectors formed by the cross of the troughs. The complete pattern is cut to a depth of about $\frac{3}{32}$". During operation, the pattern rests upon the bearing insert and wipes a circular area.

Only the weight (6 lbs.) of the rotor-spindle assembly is applied. As the machine operates, the oil on the bearing surface is swept outward through the troughs in the felt by centrifugal force; more oil is then pumped up through holes of the anchor and bearing, and thus continual contact is assured between oil and bearing.

An extremely vigorous stirring action is imparted to the oil by means of 4 aluminum fins located on the periphery of the disk of the rotor (cf Fig. 4A). The fins are placed at equal distances and are pitched at an angle of about 45° so that the oil is lifted as the rotor travels in the clockwise direction.

(c) *Gas Train:* (cf Fig. 1). Although any gas phase can be used, generally dry, CO_2-free, filtered air is swept through the apparatus. The flow of air is metered by means of a manometric type flowmeter, from which the air passes through the combined thermocouple well and air inlet. It will be noticed that the air simply passes through the vapor space and is not bubbled through the oil; efficient contact between air and oil is assured by the rapid stirring. The rate of airflow generally used allows a complete change of atmosphere approximately once each minute.

(d) *Mounting Accessories:* (cf Fig. 2). For simplicity and convenience the Corrosion and Stability Apparatus employs a conventional, bench-type drill press. Power is furnished by means of a 1/3 hp. motor. Constancy of rotation is readily maintained (±1% at 1310 R.P.M.) and is checked periodically. Heat is supplied to the vapor bath by means of a 750 watt Chromolax ring heater. Variation of heat facilitates more rapid heating-up and increases the range of operating temperatures. The apparatus has been run at temperatures ranging from room temperature to 424°F.

A simple steel framework supports the reaction vessel and holds it from slipping under the effect of the high speed rotation. It has been found expedient to insulate the reaction vessel by wrapping it with asbestos paper. The top of the reaction chamber is held firmly in place by a rubber cushion and a transite ring which are bolted to the steel frame work.

Table 1

(Standard Conditions for Corrosion and Stability Tests on Lubricants of SAE-10 and 30-Grades)

S.A.E. grade of lubricant:	10	30
Designation of test:	C & S-10	C & S-30
Temp. (both oil and bearing), °F.	363	363
Duration of test, hours	3	5
Oil charge, grams	225	225
Rotor speed, rpm.	1,310	1,310
Rate of air-venting, ml per min.	600	600
Bearing insert:		
Type:	Cu-Pb	Cu-Pb
Total area, cm^2	7.89	7.89
Area wiped, cm^2	6.17	6.17
Ratios:		
Total area of bearing per gram of oil, cm^2 per gram	0.0351	0.0351
Wiped area of bearing per gram of oil, cm^2 per gram	0.0274	0.0274

Conditions of Test

In Table 1 are listed the conditions of test employed in the evaluation of the potential service performance of S.A.E.-10 and 30 grade motor oils. These conditions permitted satisfactory correlation between the laboratory test and the 36-hour Chevrolet Engine test. (1) Subsequently, these tests have predicted with reasonable accuracy the behavior of lubricants in the Standard Caterpillar and General Motors Diesel Engine tests. (2, 4)

Effect of Changing Variables In the C & S Apparatus

Effect of Temperature

In the C and S apparatus which promotes oil oxidation and bearing corrosion, variation with change in operating temperature cannot be ascribed exclusively to either. There is a third factor, that of catalysis by the metals taken into solution from the bearing surface. The reactions involved in catalysis including rate of solution of metals and catalytic activity of dissolved metals, have been reported (9) to vary markedly and often anomalously with temperature. In general, in the C and S tests, corrosion and deterioration vary directly with temperature.

The data of Table 2 demonstrate this behavior for six oils. Oil B presents a case of particular interest. At 212 and 265°F., corrosion was scarcely measurable; development of neutralization number was also negligible (initially this oil has an alkalinity equivalent to 0.2 mg KOH per gm). However, increase in temperature of 48°F. (from 265 to 313°F.) increased both corrosion and development of neutralization number enormously. Further increase to 363°F. resulted in additional increase in potential corrosivity of only 36% and 63% increase in deterioration as measured by neutralization number. Such abrupt temperature susceptibilities which are not sustained must represent overall effect of temperature on the several involved mechanisms. Talley, Larsen and Webb (13) have observed such behavior in the Thrust Bearing Corrosion machine and suggested that the stability of protective films (lacquer and/or sludge) may be responsible.

The selection of 363°F. as the standard temperature in the C and S was made as a compromise between the crankcase temperature and that of the cylinder wall and piston area. Further, it may be held that the temperature at the bearing surface exceeds the bulk crankcase temperature.

Effect of Time

The variation with time of bearing corrosion and oil deterioration can be measured by two fundamentally different methods; (I) by setting up independent uninterrupted experiments for each time period; (II) by interrupting a run periodically and determining the increment of weight loss occurring. The latter method has an objectionable feature in that it interferes with the natural formation and functioning of protective films on the bearing surface. However, following the course of oil deterioration by periodically removing small samples from a large charge of oil results in neither basic change in the system nor interference with the course of reaction. Both Methods I and II are illustrated by

Table 2—Data Illustrating Effect of Temperature in the Corrosion and Stability Apparatus

(Bearing inserts, copper-lead; Duration of runs, 5 hours; Aeration, 600 ml per min; Stirring, 1310 rpm)

Oil	T°F.	Bearing Weight Loss mg/cm^2	Neut. Number mg KOH per gm
A; Undoped SAE 10 Viscosity Grade Motor Oil	313	0.23	0.6
	363	0.63 (0.63, 0.63)	1.7 (1.7, 1.7)
B; Oil A containing 1.0%w Deterg. DII	212	0.2	—0.2
B; Oil A containing 1.0%w Deterg. DII	265	0.1	<0.05
B; Oil A containing 1.0%w Deterg. DII	313	4.5 (3.9, 5.1)	6.4 (4.2, 8.6)
B; Oil A containing 1.0%w Deterg. DII	363	5.6	10.4
C; SAE Correlation Oil B-2 (30 grade)	313	0.24 (0.23, 0.24)	0.8 (0.6, 1.1)
C; SAE Correlation Oil B-2 (30 grade)	363	6.4 (6.3, 6.6)	4.8 (4.3, 5.2)
D; SAE Correlation Oil B-11 (10 grade)	330	0.28	0.3
D; SAE Correlation Oil B-11 (10 grade)	363	1.8 (1.4, 2.2)	0.8 (0.7, 0.8)
E; SAE Correlation Oil B-13 (10 grade)	330	2.0	0.4
E; SAE Correlation Oil B-13 (10 grade)	363	4.9 (4.5, 5.3)	1.2 (1.2, 1.1)
F*; SAE Correlation Oil B-14 (10 grade)	313	0.28	1.5
F*; SAE Correlation Oil B-14 (10 grade)	363	0.98	6.0

*Duration of runs on this oil: 16 hours.

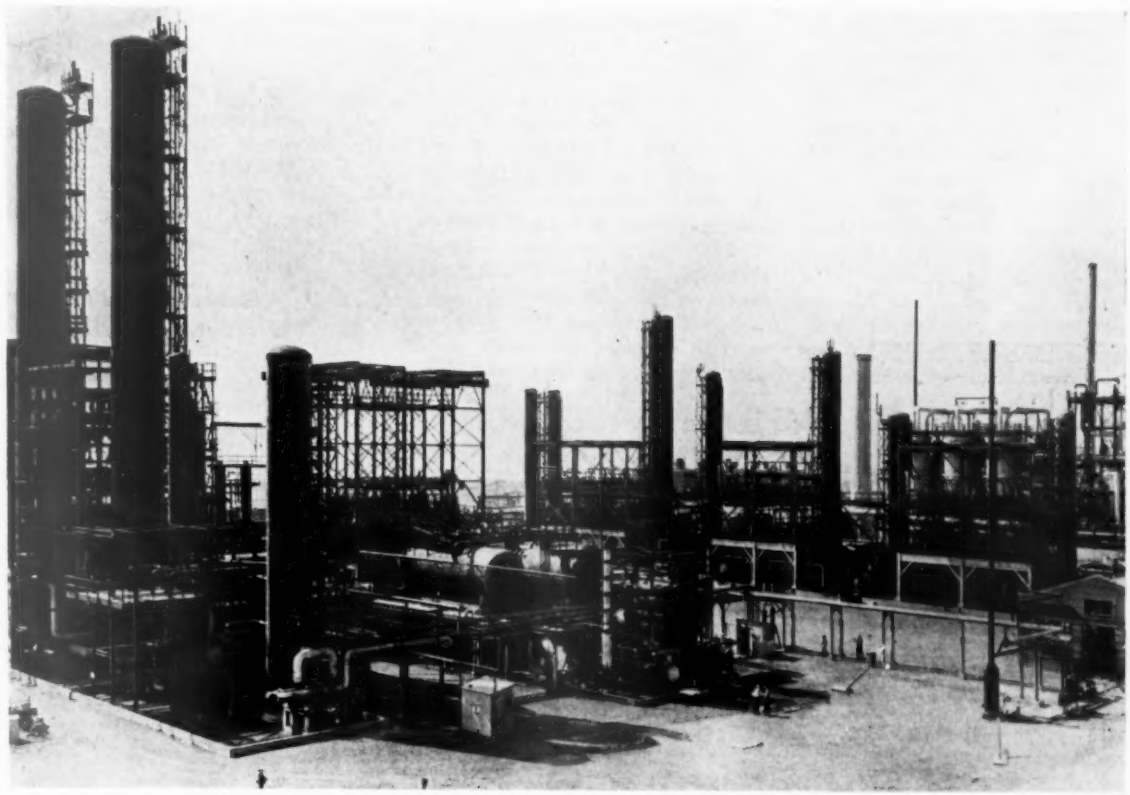
PRESSURE VESSELS

FOR

OIL REFINERIES

AND

CHEMICAL PLANTS



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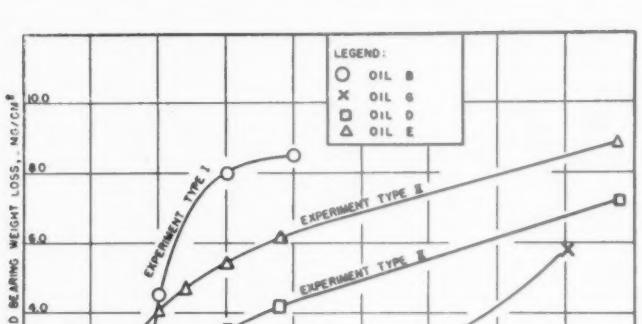

Fig. 5—Potential corrosivity measured as a function of time in the Corrosion and Stability apparatus

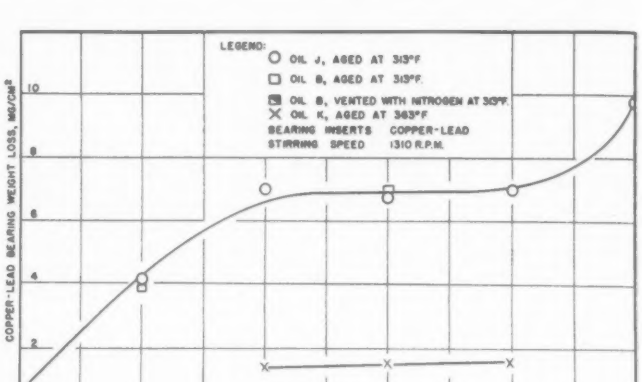
LEGEND:
OIL J, AGED AT 313°F
OIL B, AGED AT 313°F
OIL B, VENTED WITH NITROGEN AT 313°F
OIL K, AGED AT 363°F
BEARING INSERTS COPPER-LEAD
STIRRING SPEED 1310 R.P.M.
COPPER-LEAD BEARING WEIGHT LOSS, MG/CM²
VENTING RATE, ML PER MIN.

Fig. 7—Effect of venting in Corrosion and Stability apparatus

the data of Table 3. In general, with prolonged aging in the C and S, corrosivity and oil deterioration becomes more severe but by no means linearly so. The data of Table 3 are presented graphically in Fig. 5. The different shapes of the curves make difficult the selection of an arbitrary time period for rating lubricants. Since these curves cross, as shown in Fig. 5, the relative ratings of two oils may be reversed with respect to their service ratings.

The pronounced S-shaped curve for Oil B must be the net effect of a complex series of reactions. The initial induction period suggests an autocatalytic mechanism; whereas the subsequent bending over indicates an elimintion of the earlier accelerating factors. A most probable contributing factor involves the catalytic effect of metals dissolved upon the corrosion of copper-lead bearings. The data of Table 3 pertinent to Oils D and E were obtained by Method II. The shortcoming of this technique is evidenced by comparison of the figures obtained for weight loss in 3 hours using this method (1.3 mg/cm² for Oil D; 2.2 mg/cm² for Oil E) with those when the oils are allowed to age uninterruptedly under the same condition (0.79 mg/cm² for Oil D; 0.8 mg/cm² for Oil E). Not only have the weight losses been increased by following Method II, but the relative ratings of the two oils have been distorted. The technique of Method I is therefore preferred.

Periodic sampling of the oil from the reaction chamber provides a convenient means of following the course of deterioration. The data of Table 4 represent a case in which difference in quality can be definitely attributed to difference in oxidation stability.

As in the case of other physical variables, the selection of time-periods for Standard C and S Tests has been made so that results correlate with service. In testing S.A.E. 30 grade lubricants, 5 hours aging is employed; in testing S.A.E. 10 grade lubricants, 3 hours. Standard conditions of test for higher viscosity grades are not advanced due to the lack of engine data of the desired scope as provided in the "B" oils of the S.A.E. Committee. (10)

Effect of Degree of Agitation

The action of the rotor involves several factors; namely, effective contact between oil and atmosphere, dispersion of corrosive bodies and products of corrosion, and the efficiency of the felt wiping action. That degree of agitation can be a critical factor in lubricant aging tests has been demonstrated by the Indiana Stirring Oxidation Test. (6) In Table 5 and Fig. 6 are presented data indicating the effect of stirring rate upon bearing corrosion and development of neutralization number in the C and S. The data of Fig. 3A indicate that at 313°F. potential corrosivity and increase in neutralization number vary directly and slightly less than linearly with speed of rotation.

It is clear that under these conditions the contribution of the rotor to agitation is greater than that to wiping, since removal of the vanes from the rotor with the maintenance of a speed of 1310 rpm. reduced potential corrosivity and development of neutralization number to a greater degree than reduction of speed of rotation from 1310 to 660 rpm. The curves of Fig. 3B obtained upon a different oil at 363°F., and with increased airflow indicate practically no change in the nature of the interrelationships of the involved variables.

In general, there is no position on the curves of Fig. 6 preferable as a standard

Table 3—Data Illustrating Effect of Time in the Corrosion and Stability Apparatus

(Bearing inserts, copper-lead; Temperature, 363° F.; Aeration, 600 ml per min; Stirring, 1310 rpm)

Type of Run°	Oil	Hours Run	Bearing Weight Loss mg/cm²	Neut. Number mg KOH per gm
I	B Oil A containing 1.0%w Detergent DII	1	0.05	0.1
		3	0.36	1.2
		4	1.2	3.3
		5	4.5(3.9, 5.1)	6.4(4.2, 8.6)
		7.5	8.0	16
		10	8.5	19
	G SAE 30 Viscosity Grade, Undoped, Mineral Oil Distillate	5	0.91	1.1
		10	1.4	1.4
		20	5.8	2.1
II	D SAE Correlation Oil B-11 (10 grade)	1	0.72	..
		2	0.99	..
		3	1.31 (0.79)°°	..
		4	1.6	..
		5	2.1	..
		6	2.7	..
		7.5	3.5	..
		9.5	4.1	..
		21.9	7.2	4.9
	E SAE Correlation Oil B-13 (10 grade)	1	0.76	..
		2	1.4	..
		3	2.2 (0.8)°°	..
		4	3.1	..
		5	4.0	..
		6	4.6	..
		7.5	5.4	..
		9.5	6.2	..
		21.9	8.9	2.8

°I: Independent experiments made for each time period.
II: Bearing removed periodically, cleaned, weighed and returned to machine.
°°Figure in parentheses represents weight loss sustained in uninterrupted run of 3 hours.

condition. In the interests of magnifying effects, and to avoid the hazards attending high speeds, the intermediate speed of 1310 rpm has been adopted for standard C and S Tests.

Effect of Rate of Air Flow

Since a closed system does not exist in practice, venting with air has been included in the standard operation of the C and S apparatus. In the interests of precision it is regarded essential that venting be closely controlled and carried out at a rate reasonably representative of service conditions. The data of Table 6 and Fig. 7 demonstrate the effect of venting upon corrosivity and deterioration. In the range from 400 to 800 ml air per minute corrosivity remains practically constant, both at 313°F. with the S.A.E. 10 vis. oil and at 363°F. with the heavy aircraft oil. It is possible that a balance of compensating factors, such as loss of volatile products and supply of oxygen for promotion of deterioration, is destroyed at flow rates lower than 800 ml per minute. However, insufficient data are at hand to enable generalization on this point for all oils.

The close agreement in the potential corrosivities of oils J and B, under similar conditions, can be accounted for by the fact that these two oils have the same base stock, their difference lying in the identity and concentration of detergent. Assuming that the oils are peptized to the same degree, it appears that detergents DI and DII themselves do not enter into the corrosion or oxidation process; rather, they help maintain a clean and vulnerable bearing surface.

The effect of varying the composition of the venting gas is demonstrated by the data of Table 6. Replacement of air by nitrogen reduced corrosivity and deterioration to negligible values, whereas substitution of oxygen for air increased them enormously. The primary effect of variation of oxygen in this system is, of course, exerted upon oxidative reactions leading to the deterioration of the oil.

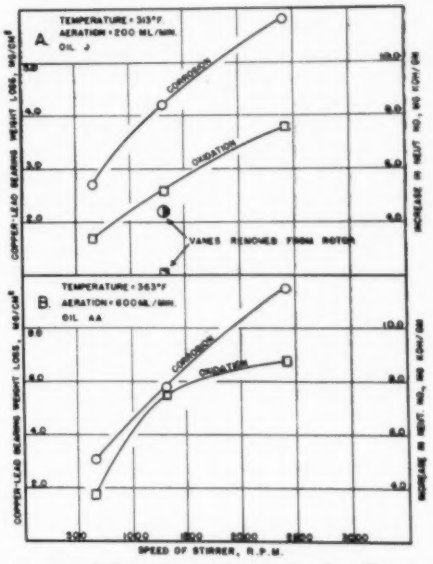

Fig. 6—Effect of agitation in the Corrosion and Stability apparatus

An airflow rate of 600 ml per minute has been selected as a standard condition for the C and S. Since free space of the reaction chamber is about 600 to 650 ml, this venting rate accomplishes a complete change of atmosphere every minute, comparing reasonably with service conditions.

Effect of Felt Wiping Action On The Bearing Surface

Although the Corrosion and Stability apparatus does not depart markedly from earlier techniques, the nature of its felt wiping action on the bearing surface is distinctive. In agreement with Clower (3), who reported that a leather wiping action improved reproducibility of bearing corrosion measurements, the felt wiping action has been found to contribute to satisfactory precision. A felt wiping action is, of course, completely artificial in terms of service. The conditions existing at the bearing-journal site of an engine have been simulated in the Thrust Bearing Corrosion machine (13) which permits the study of corrosion of a loaded bearing subjected to hydrodynamic lubrication. Only light loads on the bearing in glass equipment are possible and hence the Corrosion and Stability apparatus does not realize this fundamental aim of the Thrust Bearing Corrosion machine.

The felt wiping action is not intended to reproduce engine conditions, but assumes that rubbing of the journal against the bearing may prevent the accumulation of products of corrosion on the bearing surface and hence may exert a pronounced influence on corrosion by increasing the vulnerability of the bearing surface. It has been repeatedly observed that the felt wiping action of the C and S does not interfere with the deposition of lacquer films on the bearing by oils which

Table 4—Following the Course of Deterioration in the Corrosion and Stability Apparatus as a Function of Time

(Bearing inserts, copper-lead; Temperature, 363° F.; Aeration, 600 ml per min; Stirring, 1310 rpm)

Samples of oil (ca. 10 gm) withdrawn periodically and analyzed for neutralization number.

Time Hrs.	Oil H, Light Mineral Oil Dist. Neut. No. mg KOH per gm	Oil H, Light Mineral Oil Dist. Bearing Wgt. Loss mg/cm²	Oil I, Refined Bright Stock Neut. No. mg KOH per gm	Oil I, Refined Bright Stock Bearing Wgt. Loss mg/cm²
0	<0.05	...	<0.05	...
1	1.4	...	0.0_8	...
2	3.4	...	0.1_7	...
3	4.5	...	0.1_9	...
4	5.1	...	0.2_1	...
5	5.8	4.6	0.2_7	0.67

Table 5—Effect of Agitation in the Corrosion and Stability Apparatus

(Bearing inserts, copper-lead; Duration of test, 5 hours)

Speed of Stirring rpm	Oil J, SAE 10-vis. grade motor oil (Oil A) containing 2%w of detergent DI, Temp.=313°F. Airflow=200 ml/min. Cu-Pb Wgt. Loss mg/cm²	Oil J, Increase in Neut. No.	Oil AA, SAE 30-vis. grade motor oil containing 1%w of detergent DII, Temp.=363°F. Airflow=600 ml/min. Cu-Pb Wgt. Loss mg/cm²	Oil AA, Increase in Neut. No.
660	2.7	3.4	2.5	3.8
1310	4.2	5.2	5.9	7.5
2410	5.8	7.6	8.8	8.8
1310	2.4°	2.1°		

°Vanes removed from rotor in this experiment.

Table 6—Effect of Venting in the Corrosion and Stability Apparatus

(Bearing inserts, copper-lead; Stirring speed, 1310 rpm)

Oil	T°F	Venting Gas	Vent. Rate ml min.	Weight Loss mg per cm²	Neut. No. mg KOH per gm
J SAE 10-vis. Grade Motor Oil (Oil A) containing 2%w Detergent DI	313	None	0	0.61	0.2
Detergent DI	313	Air	200	4.2	3.2
Detergent DI	313	Air	400	7.0 (7.5,6.4)	7.0 (8.1,5.9)
Detergent DI	313	Air	600	6.8 (7.5,6.2)	8.1 (8.8,7.4)
Detergent DI	313	Air	800	7.0 (6.6,7.6,6.7)	9.2 (9.9,8.9,8.9)
Detergent DI	313	Air	1000	9.8 (12,9.1,8.4)	11 (12,11,10)
B SAE 10-vis. Grade Motor Oil (Oil A) containing 1.0%w Detergent DII	313	Air	200	3.9	4.2
Detergent DII	313	Air	600	6.9	8.0
Detergent DII	313	N_2	600	0.15	0.1
Detergent DII	313	O_2	600	35°	27
K Ashless Aircraft Oil (120-vis. grade)	363	Air	400	1.3	0.4
Oil (120-vis. grade)	363	Air	600	1.6 (1.4,1.7)	0.3 (0.3,0.3)
Oil (120-vis. grade)	363	Air	800	1.5	0.3

°This weight loss figure high since felt pad disintegrated during run allowing aluminum rotor to erode bearing.

are non-corrosive in an engine presumably because of the protection afforded the bearing by the deposition of the products of oil oxidation. The possible merits of a wiping action on the bearing surface have recently been recognized by Georgi (5) who reports the opinion that the difficulty which many laboratory tests experience in the evaluation of potential corrosivity of oils toward copper-lead bearings may be attributed to the absence of a wiping action analogous to that furnished by the journal in the engine.

In applying a felt wiping action as employed by the C and S apparatus, the possibility was recognized that overheating of the bearing surface might result. This factor was investigated by mounting a thermocouple in the bearing insert so that the junction was flush with the wiped surface. A second thermocouple was immersed in the oil and both temperatures were measured simultaneously during operation under a wide variety of conditions. The data are summarized in Table 7; bath temperature refers to that of the vapor bath of the apparatus. Measurements were made upon undoped mineral oils. The data of Table 7 indicate, as would be expected, that overheating of the bearing is most pronounced at lower bath temperatures and with more viscous oils. However, even at room temperature the heat generated at the bearing is dissipated into the oil so that the differential between oil and bearing temperature is only a small fraction of that between bath temperature and oil temperature. At the elevated temperatures, overheating of the bearing becomes negligible; even at 212°F, 150°F. below the standard temperature of operation, the maximum difference between oil and bearing is of the order of 2°F., which represents practically the limit of the measuring potentiometer employed. At 363°F. no differential could be measured between the temperatures of the oil and the bearing even in the case of the most viscous oil.

Table 8 illustrates some of the features associated with the felt wiping action of the C and S. Interpretation of the data includes the following:

(a) Items Nos. 1, 2, 5 and 6 indicate that corrosion is drastically reduced by omission of wiping over a temperature range of more than 100°F., both when corrosion is low (No. 1 and 2) and when it is relatively high (No. 5 and 6).

(b) Items Nos. 3a, 3b, 4a and 4b show that when both wiped and unwiped bearings are included in the same run, omission of wiping can reduce corrosion by about 50%. It would be entirely hazardous to generalize further.

(c) A critical question involved in the use of any wiping action is the possibility of erosion. Extended experience has shown that with Cu-Pb, Cd-Ni, and pure aluminum bearing inserts, the felt wiping action of the C and S causes no appreciable erosion at temperatures of the order of 313 to 363°F. This is illustrated by the extremely low weight losses obtained under items No. 9, 10 and 11.

Bearing inserts of these three types are illustrated in Fig. 8 both unused and after runs in the C and S. The circular pattern evident upon the used inserts is a universal characteristic of the test and is not associated directly with the occurrence or magnitude of corrosion. The even and continual flow of oil over the bearing surface in the C and S is undoubtedly responsible for the prevention of erosion. Erosion has failed to occur seriously with a copper-lead bearing run at room temperature (cf. Item No. 7, Table 8) although lubrication, due to the relatively high viscosity of the oil, was so poor that friction overheated the oil from 85 to 114°F. The lead-flashed coper-lead bearing illustrated as C and C_1 in Fig. 8 constitutes an exception in that it is subject to erosion in the C and S both at high and room temperatures.

Comparison of Items Nos. 7 and 8 of Table 7 readily discloses the susceptibility of lead-flashed copper-lead bearings to wear. The surface coating of lead is evidently in a soft, aggregate form which while supplying "imbedability" is particularly vulnerable to wear. Despite losses through wear, good precision is nevertheless maintained and differences in corrosivities of oils shown in the C and S toward lead-flashed bearings are considered real.

(d) As stated above, the wiping action of the C and S is intended to remove products of corrosion and disperse them throughout the oil. It is essential that the wiping does not interfere with the formation and tenacity of naturally-occurring, protective films such as those of lacquer and/or sludge. That this does not occur in the C and S has been repeatedly observed; an illustrative case is given in items Nos. 12 and 13 of Table 8. Oil A shows low potential corrosivity through the protection of a lacquer film which is clearly visible on the bearing surface after the run; this bearing is pictured as A_1 in Fig. 8. Incorporation of detergent DII or any compound which, like it, possesses no corrosive or pro-oxidant properties in itself but is capable through peptization of preventing the formation of protective films by the oil, increases the corrosivity of the oil markedly. Compare the polished appearance of the bearing (A_2 of Fig. 8) with the dull, lacquer-covered bearing (A_1). In other words, such lacquer and/or sludge films although susceptible to chemical dispersion are impervious to the mechanical action of the C and S.

Use of Catalyst

There exist conflicting opinions upon the incorporation of catalysts, e.g., metals and metal soaps, in laboratory oil aging

Table 7—Oil and Bearing Surface Temps. in the C & S Apparatus During Operation

(Aeration, 600 ml per min; Stirring, 1310 rpm; Duration, Until equilibrium temperature attained)

	Temperature of Vapor Bath of C & S					
	Room (75-85°F)		212°F		363°F	
Vis. of Min. Oil, S.U.S. at 100°F	—Equil. T. °F of— Oil	Bearing	—Equil. T. °F of— Oil	Bearing	—Equil. T. °F of— Oil	Bearing
100	137	140	215	215	...	...
550	151	161	...	...	...	...
2750	..	...	218	220	361	361

Table 8—Effect of Felt Wiping of the Bearing Surface in the Corrosion and Stability Apparatus

Item	Oil	Bearing	T°F	Hours run	Ml. air per min	Wgt. Loss mg per cm²	Neut. No. mg KOH per gm	Remarks
1;	A, Undoped SAE-10 visc. grade motor oil	Cu-Pb	313	7	200	0.57	1.4	Regular wiping action, catalyst present
2;	A, Undoped SAE-10 visc. grade motor oil	Cu-Pb	313	7	200	0.04	1.2	Rotor raised, no wiping, catalyst present
3a	A, Undoped SAE-10 visc. grade motor oil	Cu-Pb	313	7	200	0.27	1.3	Two bearings included in same run;
3b	A, Undoped SAE-10 visc. grade motor oil	Cu-Pb	313	7	200	0.14	1.3	3a wiped, 3b unwiped
4a	J, Oil A containing 2%w Detergent DI	Cu-Pb	313	5	200	6.6	4.5	Two bearings included in same run;
4b	J, Oil A containing 2%w Detergent DI	Cu-Pb	313	5	200	3.4	4.5	4a wiped, 4b unwiped
5;	L, Experimental aircraft oil (120 grade) containing inhibitor and detergent	Cu-Pb	424	5	600	4.8	0.9	Regular wiping action
6;	L, Experimental aircraft oil (120 grade) containing inhibitor and detergent	Cu-Pb	424	5	600	0.91	1.3	Wiping omitted
7;	H, Light mineral oil distillate	Cu-Pb	85	5	600	0.3	<0.05	Oil overheated during run to 114° F.
8;	H, Light mineral oil distillate	Pb-flashed Cu-Pb	85	5	600	4.9	<0.05	Oil overheated during run to 125° F.
9;	M, Commercial aircraft oil, 120 grade	Cd-Ni	363	5	600	0.02	0.2	Regular wiping action
10;	A, Undoped SAE-10 vis. grade motor oil	Cu-Pb	313	7	200	0.04	1.2	Regular wiping action
11;	N, SAE Correlation Oil B-4 (30 grade)	Al	363	5	600	0.03	3.3	Regular wiping action, catalyst present
12;	A, Undoped SAE-10 vis. grade motor oil	Cu-Pb	363	5	600	0.63, 0.63	1.7, 1.7	Regular wiping action
13;	B, Oil A containing 1.5%w detergent DII	Cu-Pb	363	5	600	4.5	10.3	Regular wiping action

tests. The contact with metals which lubricants encounter in service constitutes the strongest argument for including metal catalysis in a test. However, such questions as the form of catalyst, the type of metals, the concentration or extent of exposure remain uncertain. Larsen and Armfield (7) have proposed a novel catalyst in their so-called "crankcase catalyst" which represents a derivation from lubricants aged in actual service.

In the standard C and S tests, the only real source of catalysis by metals is the copper-lead bearing insert, since aluminum is generally recognized to be relatively inactive. This constitutes definitely a departure from conditions of an engine in which exposure to metals, principally iron, is outstanding. However, the standard conditions were chosen empirically to obtain favorable comparison between C and S tests and engine performance. On the oils discussed in this paper, this was achieved without inclusion of extraneous metal catalysts. However, ample provision has been made for the inclusion of catalysts, and the importance of this factor is fully recognized. Soluble catalysts, of course, can be employed directly in the oil; elementary metals are readily included in the form of strips or wire resting on the bottom of the reaction vessel. Only the use of catalysts in the form of potential abrasives, e.g., metal powders, etc., is precluded in the standard C and S tests, since they obviously would interfere through their erosive action.

It is to be realized, however, that the copper-lead surface constitutes an appreciable source of catalyst, since high weight loss is normally accompanied by severe oil deterioration. The only exceptions to this behavior have been some oils which, while excessively corrosive, contained some potent anti-catalyst or powerful anti-oxidant.

It is visualized that extension in the scope of the apparatus, as well as improvement in accuracy and, hence, usefulness of the test, may be effected through the addition of catalysts.

(End Part 1)

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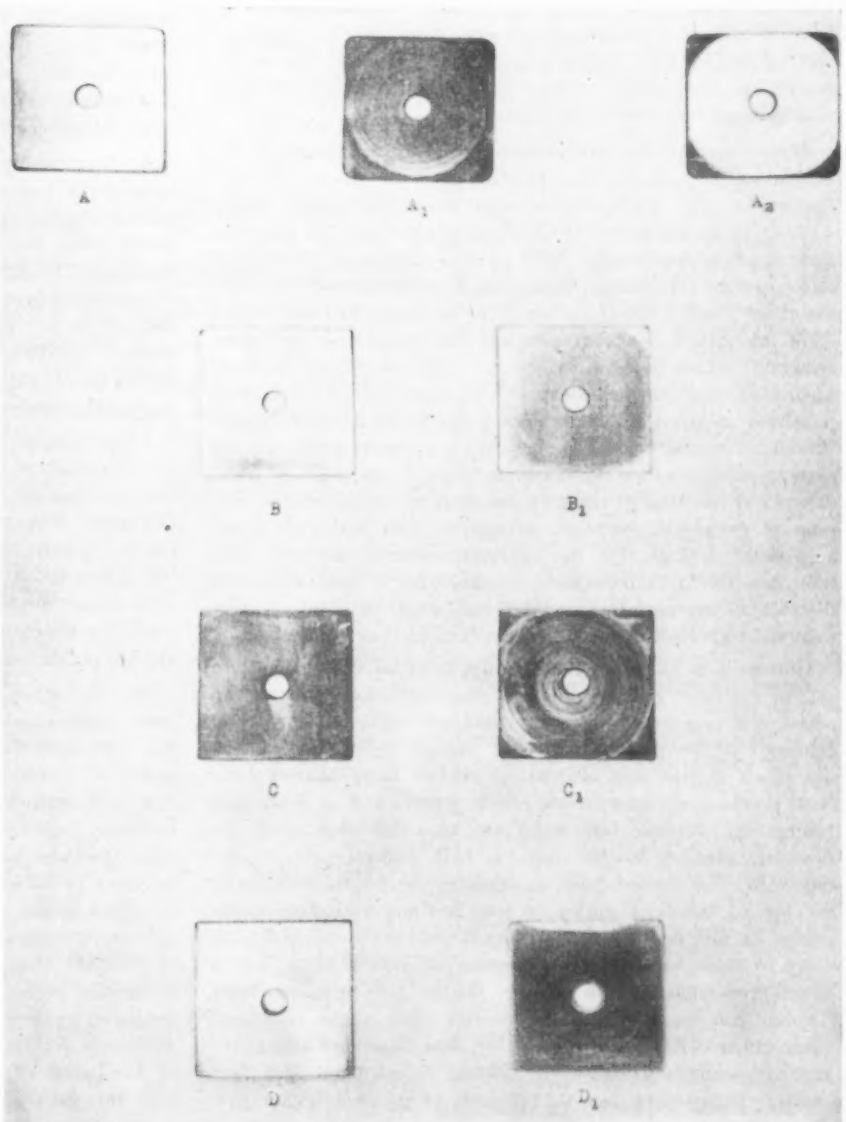

Fig. 8—Bearing inserts for the C. and S. apparatus: A. copper-lead, unsued; A_1, copper-lead run in lacquering oil; A_2, copper-lead run in detergent oil; B, cadmium-nickel, unused; B_1, cadmium-nickel, used; C, lead-flashed copper-lead unused; C_1, lead-flashed cop- apparatus: A, copper-lead, unused; D_1, aluminum, used

WIDENING HORIZONS

Views on Personnel, Management and Economic as Well as Technological Developments in Petroleum Refining and Natural Gas Processing: Comment from Readers Is Invited

Butadiene from Alcohol Favored By Special Material Priorities

PUBLIC COMMENT from some members of Congress and elsewhere considers alcohol to be the chief raw material for synthetic rubber production because, so it is said or inferred, the plan to use a petroleum derivative has not come up to expectations. Such statements not only are erroneous as far as the wartime rubber program is concerned but, what is more serious, they warp consideration of the part the petroleum synthetic plants will play in supplying the rubber market after the war.

It is true that up to the present time the great part of butadiene is coming from alcohol rather than from the butylenes from petroleum refineries. However, this is not because of any miscalculation of economic or technical factors when the program for permanent butadiene plants was set up. The butadiene-from-alcohol plants were 87% completed and operating last November, Rubber Director Dewey reported at that time, while the butadiene-from-petroleum plants were only 39% completed.

Three reasons for the difference in the progress of the plants were given by the Rubber Director in his Progress Report No. 4. First, the alcohol butadiene plants almost without exception received the highest priorities for materials and supplies, while only 40% of the petroleum plants had that priority advantage during their construction. Second, the three alcohol plants are made up of identical units, which involved only one design problem and simplified their construction. Development work to find the most suitable separation and purification methods, among other technical problems, delayed the petroleum program in its early stages. The third reason was that the butylenes from refineries are materials for aviation gasoline components as well as butadiene. While the oil industry has greatly increased the volume of butylenes supplied, manpower and materials shortages delayed producing the amounts required for both aviation gasoline and butadiene manufacture. It is estimated that within the next few weeks the shortage of plant capacity to make butadiene from petroleum will be overcome.

However, in assuming that alcohol is to be the chief factor in the synthetic rubber program, the critics of rubber-from-petroleum overlook two points that will have an important bearing on the postwar synthetic rubber program. One is the much higher cost of making rubber from alcohol from farm produce, a factor which can be overlooked in a wartime emergency program, but will come into full play when the synthetic product has to compete with natural rubber after the war. The second point is whether the public will justify the use of the feed grains or any produce with food value grown in this country for making a rubber chemical in the years to come when this nation will be looked to to feed a large proportion of the people in the war-torn countries. Alcohol can be made from molasses from sugar cane and other crops of no great food value, but those are not raised in this country in sufficient volume to supplant the feed grains. Developing and raising new crops or bringing produce in from other countries would be a complicating factor.

On the matter of price, Rubber Director Dewey stated in a recent talk that, assuming that crude oil prices continue at their present levels and valuing butylene at the present cost of motor gasoline at the refinery, the cost of producing Buna-S rubber after the war, including plant depreciation, might be around 13 to 14c a pound. If the synthetic rubber plants now owned by the government were turned over to private enterprise to operate after the war, at a reasonable cost for the plants, that cost could likely be reduced by possibly a cent a pound. A rubber authority has estimated that natural rubber from good plantations can be delivered into New York after the war at from 12 to 14c a pound.

The statement of another authority that, due to the high cost of grain, alcohol made from agricultural products costs over five times as much as ethyl alcohol made from petroleum, also indicates a much higher cost of making butadiene from alcohol than from butylene from petroleum. The government's price for Buna-S rubber was given by Rubber Director Dewey in his report of last November as 36c a pound. This price, he said, was based on the average cost of all the production at that time, of which but a small proportion was from butadiene from petroleum.

Another rubber authority has stated that, even if the grain were given free of charge to the rubber manufacturing companies, alcohol could not be produced from it at a cost that would allow the production of synthetic rubber at under 15c a pound. In times of excess supplies of grain, it was said, the resulting low prices to the farmer would affect their buying power for tires and other commodities. On the other hand, in periods of high prices for grain and high buying power for the farmers, the cost of the agricultural alcohol to the rubber companies would be exorbitantly high.

As to supply of raw materials, a recent report from the War Production Board estimates the demand for alcohol for the manufacture of synthetic rubber in 1944 will be 328,000,000 gals. This is more than half the total estimated demand for the country of 632,000,000 gals. In 1943 only 127,000,000 gals. of alcohol went to make synthetic rubber. The War Food Administration some months ago refused to release the necessary supplies of grain for proposed new grain alcohol plants.

On the other hand, authorities in the oil industry, who have studied automotive needs for petroleum products after the war, state the facilities are ample, based on present estimates of crude oil production, to supply both automotive fuel and synthetic rubber needs until 1950. Under normal balanced operations it is estimated that refineries produce approximately one per cent of their crude throughput as butylene or its equivalent. This potential supply of butylene is sufficient for the production of 1,400,000 tons annually of rubber, it is said, more than double our peak consumption of 650,000 tons. Assuming 75% of the butylene to be recoverable, more than ample supplies of butadiene would be available to the synthetic rubber industry if it were supplying all needs and no natural rubber were imported. The 99% of the barrel of crude remaining would be sufficient to provide the gasoline and lubricants needed, it is stated.

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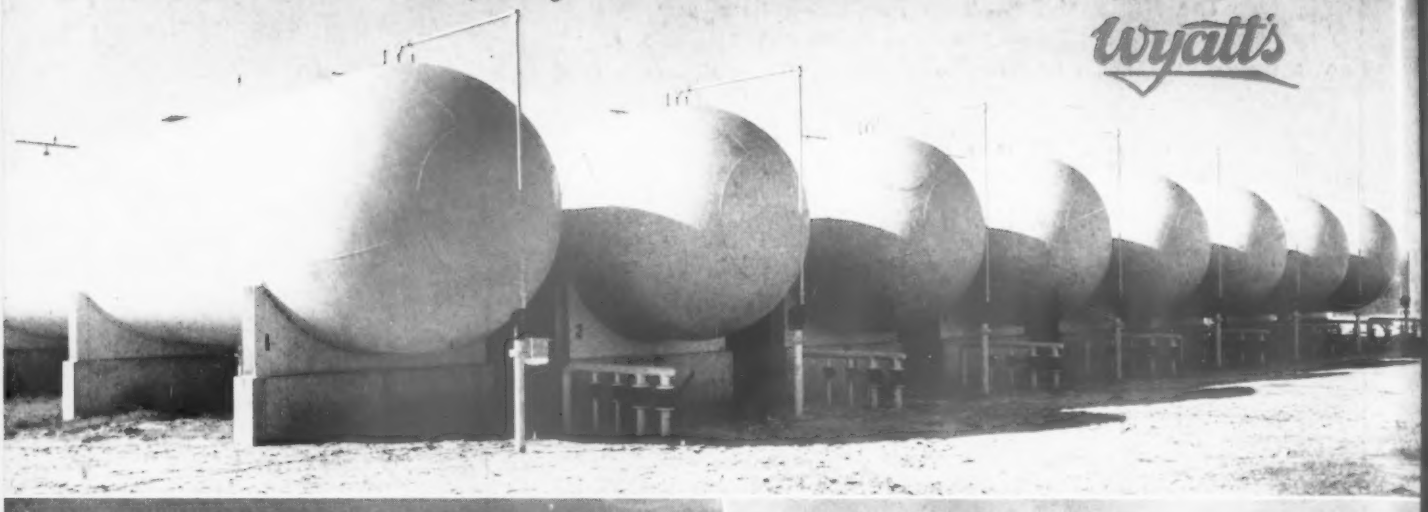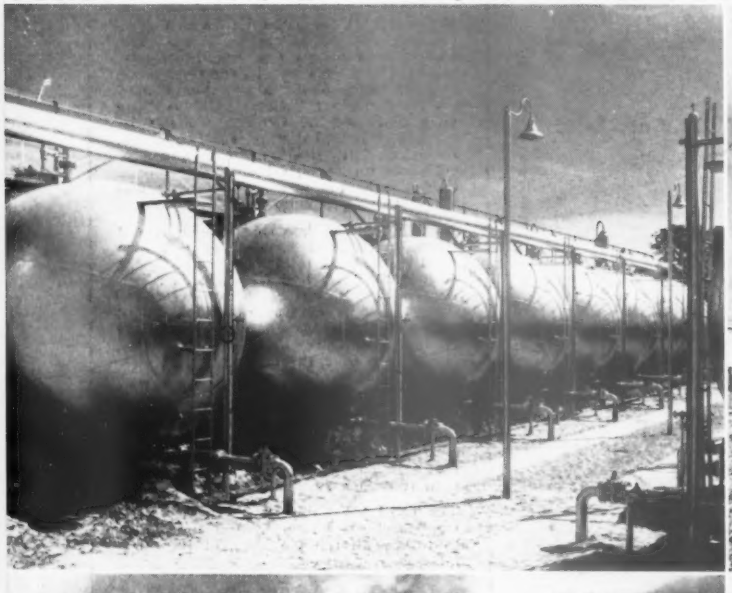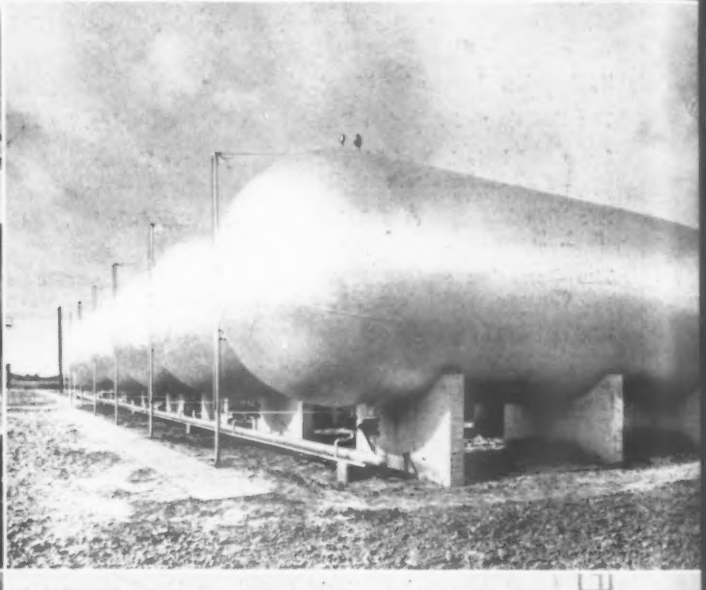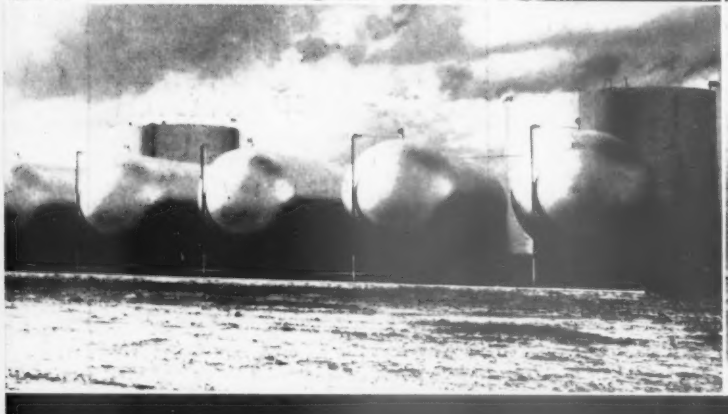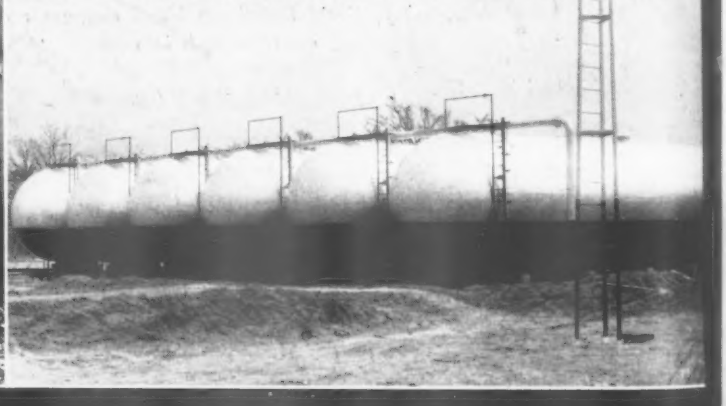
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